TOTAL MAXIMUM DAILY LOAD (TMDL)

For

Fecal Coliform

In

North Fork of the South Fork Forked Deer River
Johnson Creek
Three Segments of South Fork Forked Deer River
Located In The
South Fork Forked Deer River Watershed (HUC 08010205)
Lauderdale, Madison, and Haywood Counties, Tennessee

Prepared by:

U.S. Environmental Protection Agency, Region 4

And

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BMP	Best Management Practices
CFS	Cubic Feet per Second
DEM	Digital Elevation Model
DMR	Discharge Monitoring Report
DWPC	Division of Water Pollution Control
EPA	Environmental Protection Agency
GIS	Geographic Information System
HSPF	Hydrological Simulation Program - FORTRAN
HUC	Hydrologic Unit Code
LA	Load Allocation
MGD	Million Gallons per Day
MOS	Margin of Safety
MRLC	Multi-Resolution Land Characteristic
NPDES	National Pollutant Discharge Elimination System
NPSM	Nonpoint Source Model
NRCS	Natural Resources Conservation Service
Rf3	Reach File 3
RM	River Mile
SFFDR	South Fork Forked Deer River
STORET	STORage RETrieval database
TDEC	Tennessee Department of Environment & Conservation
TMDL	Total Maximum Daily Load
TWRA	Tennessee Wildlife Resources Agency
USGS	United States Geological Survey
WCS	Watershed Characterization System
WLA	Waste Load Allocation

SUMMARY SHEET
Proposed Total Maximum Daily Load (TMDL)
South Fork Forked Deer River - At Confluence of Sumrow Creek

1. 303(d) Listed Waterbody Information
State: Tennessee
County: Lauderdale

Major River Basin: Obion – Forked Deer Basin
Watershed: South Fork Forked Deer River (HUC08010205)

Waterbody Name: South Fork Forked Deer River
Waterbody ID: TN08010205003
Location: Confluence of Sumrow Creek to confluence with Nixon Creek
Impacted Stream Length: 40.6 miles Partially Supporting
Watershed Area: 1065 square miles
Tributary to: Forked Deer River

Constituent(s) of Concern: Fecal Coliform Bacteria

Designated Uses: Fish and Aquatic Life, Recreation, Livestock Watering & Wildlife, Irrigation, and Navigation (main stem only)

Applicable Water Quality Standard for Recreation (most stringent standard):
The concentration of the fecal coliform group shall not exceed 200 per 100 ml as a geometric mean based on a minimum of 10 samples collected from a given sampling site over a period of not more than 30 days with individual samples being collected at intervals of not less than 12 hours. In addition, the concentration of the fecal coliform group in any individual sample shall not exceed 1,000 per 100 ml.

2. TMDL Development
Analysis/Modeling:
The Non-Point Source Model (NPSM) was used to develop this TMDL. An hourly time step was used to simulate hydrologic and water quality conditions with results expressed as daily averages.

Critical Conditions:
A simulation period of 10 years was used to assess the water quality standards for this TMDL representing a range of hydrologic and meteorological conditions.

Seasonal Variation:
A simulation period of 10 years was used to assess the water quality standards for this TMDL. This period includes seasonal variations.

3. Allocation Watershed/Stream Reach:

Wasteload Allocations (WLA): 5.45 x 10^{12} counts/30 days
Note: All future permitted discharges shall meet the water quality standard for fecal coliform bacteria of 200-counts/100 ml.

Load Allocation (LA): 2.55 x 10^{14} counts/30 days

Margin of Safety (MOS): 20 counts/100 ml; conservative modeling assumptions

Total Maximum Daily Load (TMDL): 2.60 x 10^{14} counts/30 days, 180 counts/100 ml

SUMMARY SHEET
Proposed Total Maximum Daily Load (TMDL)
South Fork Forked Deer – At Confluence of Nixon Creek

1. 303(d) Listed Waterbody Information
State: Tennessee
County: Haywood

Major River Basin: Obion – Forked Deer Basin
Watershed : South Fork Forked Deer River (HUC 08010205)

Waterbody Name: South Fork Forked Deer River
Waterbody ID: TN08010205010
Location: Confluence of Nixon Creek to Mud Creek
Impacted Stream Length: 86.7 miles Partially Supporting
Watershed Area: 828 square miles
Tributary to: Forked Deer River

Constituent(s) of Concern: Fecal Coliform Bacteria

Designated Uses: Fish and Aquatic Life, Recreation, Livestock Watering & Wildlife, Irrigation, and Navigation (main stem only)

Applicable Water Quality Standard for Recreation (most stringent standard):
The concentration of the fecal coliform group shall not exceed 200 per 100 ml as a geometric mean based on a minimum of 10 samples collected from a given sampling site over a period of not more than 30 days with individual samples being collected at intervals of not less than 12 hours. In addition, the concentration of the fecal coliform group in any individual sample shall not exceed 1,000 per 100 ml.

2. TMDL Development
Analysis/Modeling:
The Non-Point Source Model (NPSM) was used to develop this TMDL. An hourly time step was used to simulate hydrologic and water quality conditions with results expressed as daily averages.

Critical Conditions:
A simulation period of 10 years was used to assess the water quality standards for this TMDL representing a range of hydrologic and meteorological conditions.

Seasonal Variation:
A simulation period of 10 years was used to assess the water quality standards for this TMDL. This period includes seasonal variations.

3. Allocation Watershed/Stream Reach:

Wasteload Allocations (WLA): 5.45 x 10^{12} counts/30 days
Note: All future permitted discharges shall meet the water quality standard for fecal coliform bacteria of 200/100 ml.

Load Allocation (LA): 1.78 x 10^{14} counts/30 days

Margin of Safety (MOS): 20 counts/100 ml; conservative modeling assumptions

Total Maximum Daily Load (TMDL): 1.83 x 10^{14} counts/30 days, 180 counts/100 ml

SUMMARY SHEET
Proposed Total Maximum Daily Load (TMDL)
South Fork Forked Deer – At Confluence of Mud Creek

1. 303(d) Listed Waterbody Information
State: Tennessee
County: Madison

Major River Basin: Obion – Forked Deer Basin
Watershed: South Fork Forked Deer River (HUC 08010205)

Waterbody Name: South Fork Forked Deer River
Waterbody ID: TN08010205012
Location: Confluence of Mud Creek to Meridian Creek, plus Panther Creek
Impacted Stream Length: 238.3 miles Partially Supporting, 9.7 miles Not Supporting
Watershed Area: 696 square miles
Tributary to: Forked Deer River

Constituent(s) of Concern: Fecal Coliform Bacteria

Designated Uses: Fish and Aquatic Life, Recreation, Livestock Watering & Wildlife, Irrigation, and Navigation (main stem only)

Applicable Water Quality Standard for Recreation (most stringent standard):
The concentration of the fecal coliform group shall not exceed 200 per 100 ml as a geometric mean based on a minimum of 10 samples collected from a given sampling site over a period of not more than 30 days with individual samples being collected at intervals of not less than 12 hours. In addition, the concentration of the fecal coliform group in any individual sample shall not exceed 1,000 per 100 ml.

2. TMDL Development
Analysis/Modeling:
The Non-Point Source Model (NPSM) was used to develop this TMDL. An hourly time step was used to simulate hydrologic and water quality conditions with results expressed as daily averages.

Critical Conditions:
A simulation period of 10 years was used to assess the water quality standards for this TMDL representing a range of hydrologic and meteorological conditions.

Seasonal Variation:
A simulation period of 10 years was used to assess the water quality standards for this TMDL. This period includes seasonal variations.

3. Allocation Watershed/Stream Reach:

Wasteload Allocations (WLA): 4.89×10^{12} counts/30 days
Note: All future permitted discharges shall meet the water quality standard for fecal coliform bacteria of 200/100 ml.

Load Allocation (LA): 1.59×10^{14} counts/30 days

Margin of Safety (MOS): 20 counts/100 ml; conservative modeling assumptions

Total Maximum Daily Load (TMDL): 1.64×10^{14} counts/30 days, 180 counts/100 ml

SUMMARY SHEET
Proposed Total Maximum Daily Load (TMDL)
Johnson Creek

1. 303(d) Listed Waterbody Information
State: Tennessee
County: Madison

Major River Basin: Orion – Forked Deer Basin
Watershed: South Fork Forked Deer River (HUC 08010205)

Waterbody Name: Johnson Creek
Waterbody ID: TN08010205015
Location: Johnson Creek from mouth to origin
Impacted Stream Length: 55 miles Partially Supporting
Watershed Area: 36 square miles
Tributary to: South Fork Forked Deer River

Constituent(s) of Concern: Fecal Coliform Bacteria

Designated Uses: Fish and Aquatic Life, Recreation, Livestock Watering & Wildlife, and Irrigation

Applicable Water Quality Standard for Recreation (most stringent standard):
The concentration of the fecal coliform group shall not exceed 200 per 100 ml as a geometric mean based on a minimum of 10 samples collected from a given sampling site over a period of not more than 30 days with individual samples being collected at intervals of not less than 12 hours. In addition, the concentration of the fecal coliform group in any individual sample shall not exceed 1,000 per 100 ml.

2. TMDL Development
Analysis/Modeling:
The Non-Point Source Model (NPSM) was used to develop this TMDL. An hourly time step was used to simulate hydrologic and water quality conditions with results expressed as daily averages.

Critical Conditions:
A simulation period of 10 years was used to assess the water quality standards for this TMDL representing a range of hydrologic and meteorological conditions.

Seasonal Variation:
A simulation period of 10 years was used to assess the water quality standards for this TMDL. This period includes seasonal variations.

3. Allocation Watershed/Stream Reach:

Wasteload Allocations (WLA): 6.47 x 10^9 counts/30 days
Note: All future permitted discharges shall meet the water quality standard for fecal coliform bacteria of 200/100 ml.

Load Allocation (LA): 2.38 x 10^{12} counts/30 days

Margin of Safety (MOS): 20 counts/100 ml; conservative modeling assumptions

Total Maximum Daily Load (TMDL): 2.39 x 10^{12} counts/30 day, 180 counts/100 ml

SUMMARY SHEET
Proposed Total Maximum Daily Load (TMDL)
North Fork of the South Fork Forked Deer River

1. 303(d) Listed Waterbody Information
State: Tennessee
County: Madison

Major River Basin: Orion – Forked Deer Basin
Watershed: South Fork Forked Deer River (HUC 08010205)

Waterbody Name: North Fork South Fork Forked Deer River
Waterbody ID: TN08010205028B
Location: From mouth to origin
Impacted Stream Length: 17.5 miles Partially Supporting
Watershed Area: 163 square miles
Tributary to: South Fork Forked Deer River

Constituent(s) of Concern: Fecal Coliform Bacteria

Designated Uses: Fish and Aquatic Life, Recreation, Livestock Watering & Wildlife, and Irrigation

Applicable Water Quality Standard for Recreation (most stringent standard):
The concentration of the fecal coliform group shall not exceed 200 per 100 ml as a geometric mean based on a minimum of 10 samples collected from a given sampling site over a period of not more than 30 days with individual samples being collected at intervals of not less than 12 hours. In addition, the concentration of the fecal coliform group in any individual sample shall not exceed 1,000 per 100 ml.

2. TMDL Development
Analysis/Modeling:
The Non-Point Source Model (NPSM) was used to develop this TMDL. An hourly time step was used to simulate hydrologic and water quality conditions with results expressed as daily averages.

Critical Conditions:
A simulation period of 10 years was used to assess the water quality standards for this TMDL representing a range of hydrologic and meteorological conditions.

Seasonal Variation:
A simulation period of 10 years was used to assess the water quality standards for this TMDL. This period includes seasonal variations.

3. Allocation Watershed/Stream Reach:

Wasteload Allocations (WLA): 1.14×10^9 counts/30 days
Note: All future permitted discharges shall meet the water quality standard for fecal coliform bacteria of 200/100 ml.

Load Allocation (LA): 8.99×10^{12} counts/30 days

Margin of Safety (MOS): 20 counts/100 ml; conservative modeling assumptions

Total Maximum Daily Load (TMDL): 8.99×10^{12} counts/30 day, 180 counts/100 ml

FECAL COLIFORM TOTAL MAXIMUM DAILY LOAD (TMDL)
SOUTH FORK FORKED DEER WATERSHED (HUC 08010205)

North Fork Of The South Fork Forked Deer River (TN08010205028)
Johnson Creek (TN08010205015)
South Fork Forked Deer River (TN08010205003)
South Fork Forked Deer River (TN08010205010)
South Fork Forked Deer River (TN08010205012)

1.0 INTRODUCTION

Section 303(d) of the Clean Water Act requires each state to list those waters within its boundaries for which technology based effluent limitations are not stringent enough to protect any water quality standard applicable to such waters. Listed waters are prioritized with respect to designated use classifications and the severity of pollution. In accordance with this prioritization, states are required to develop Total Maximum Daily Loads (TMDLs) for those water bodies that are not meeting designated uses. The TMDL process establishes the allowable loadings of pollutants or other quantifiable parameters for a waterbody based on the relationship between pollution sources and in-stream water quality conditions, so that states can establish water quality based controls to reduce pollution from both point and nonpoint sources and restore and maintain the quality of their water resources (USEPA, 1991).

2.0 WATERSHED DESCRIPTION

The South Fork Forked Deer River (SFFDR) watershed (HUC 08010205) is located in western Tennessee (Figure 1) and falls within the Level III Mississippi Valley Loess Plains (74) and Southeastern Plains (65) ecoregions. Portions of the watershed, upstream of Jackson, are in the Level IV Southeastern Plains and Hills subecoregion (65e) and are typified by increased gradients, generally sandy substrates, and distinctive faunal characteristics for West Tennessee. Most of the remainder of the watershed is located in the Level IV Loess Plains subecoregion (74b). Streams in this subecoregion are generally low gradient and murky with silt and sand bottoms, and most have been channelized (USEPA, 1997). A small section of the watershed, near the mouth, is in the Level IV Bluff Hills subecoregion (74a).

The SFFDR watershed has approximately 1,781 miles of streams and drains a total area of 1,065 square miles. The North Fork of the South Fork Forked Deer River (hereafter referred to as the North Fork) and Johnson Creek are tributaries of the SFFDR and have approximate drainage areas of 163 and 36 square miles respectively. Watershed land use distribution is based on the Multi-Resolution Land Characteristic (MRLC) databases derived from Landsat Thematic Mapper digital images from the period 1990-1993. Land use is summarized in Table 1 and shown in Figure 2. The designated use classifications for all surface waters in the SFFDR watershed include fish and aquatic life, irrigation, livestock watering & wildlife, and recreation. In addition, the main stem of the SFFDR is classified for navigation from the mouth to river mile (RM) 70.3.

Figure 1   Location of South Fork Forked Deer River Watershed

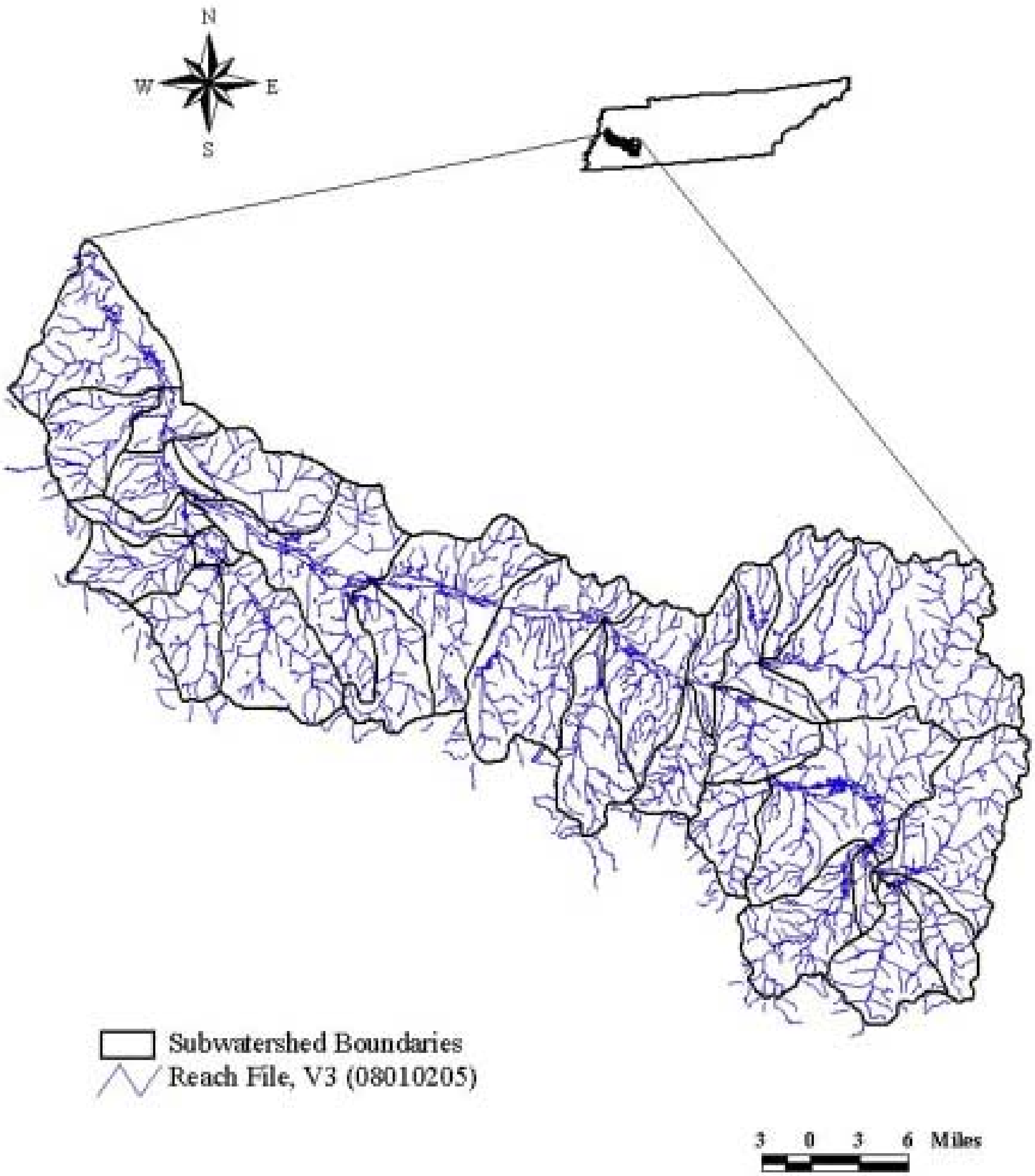
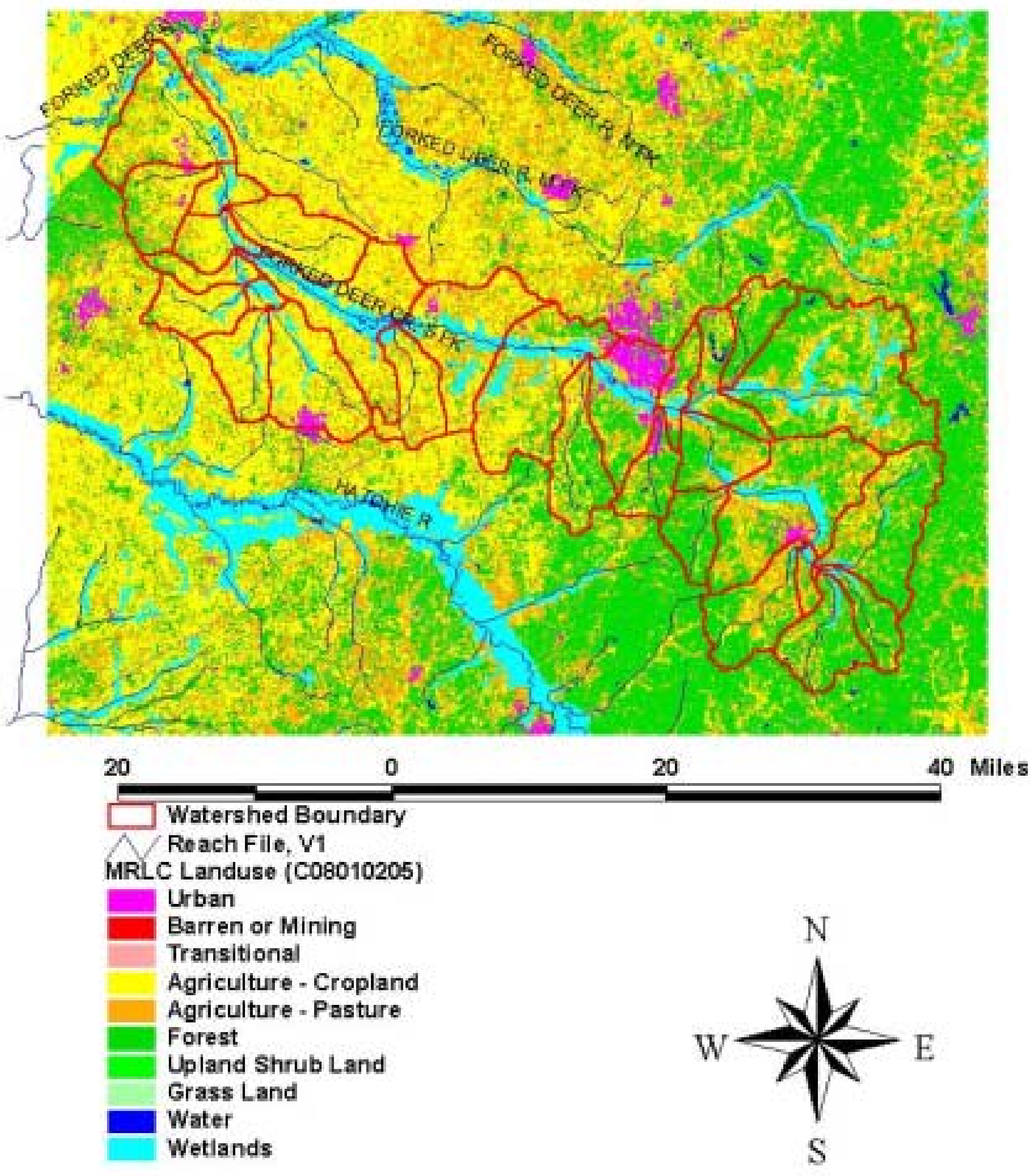


Table 1   Land Use Distribution

Land use	SFFDR (Sumrow Cr. To Nixon Cr.)		SFFDR (Nixon Creek to headwaters)		SFFDR (Mud Creek to headwaters)		Johnson Creek		North Fork Of the SFFDR	
	Area [acres]	Area [%]	Area [acres]	Area [%]	Area [acres]	Area [%]	Area [acres]	Area [%]	Area [acres]	Area [%]
Deciduous Forest	150324	22.1	139855	26.4	137445	30.8	7423	32.3	39218	37.5
Emergent Herbaceous Wetlands	7879	1.3	7879	1.5	6781	1.5	8	0	1818	1.7
Evergreen Forest	21206	3.1	20403	3.9	20248	4.5	1220	5.3	4355	4.2
High Intensity Commercial/ Industrial/ Transport.	2914	0.4	2343	0.4	2201	0.5	105	0.5	118	0.1
High Intensity Residential	2391	0.4	1663	0.4	1654	0.4	0	0	17	0
Low Intensity Residential	10727	1.6	9170	1.7	9047	2.0	30	0.1	333	0.3
Mixed Forest	37814	5.5	32377	6.1	30931	6.9	2041	8.9	7176	6.9
Open Water	5120	0.8	4184	0.8	3086	0.7	223	0.1	1065	1.0
Other Grasses Urban/Recre-ational	2012	0.3	1365	0.3	1354	0.3	518	2.3	5	0
Pasture/Hay	150724	22.1	121039	22.8	102315	23.0	4435	19.3	22613	21.6
Quarries/Strip Mines/Gravel Pits	25	0	25	0	25	0	0	0	0	0
Row Crops	237936	34.8	148040	27.9	97826	22	6918	30.1	19269	18.4
Transitional	951	0.1	681	0.1	657	0.2	28	0.1	135	0.1
Woody Wetlands	51704	7.6	40878	7.7	32016	7.2	60	0.3	8433	8.1
Total	681729	100	529903	100	445586	100	23009	100	104556	100

Figure 2 Land Use Distribution



3.0 PROBLEM DEFINITION

EPA Region IV approved Tennessee's final 1998 303(d) list on September 17, 1998. The list identified the waterbodies shown in Table 2 as not fully supporting designated use classifications due, in part, to pathogens. The fecal coliform group is an indicator of the presence of pathogens in a stream. The objective of this study is to develop fecal coliform TMDLs for 303(d) listed waterbodies in the South Fork Forked Deer River watershed.

Table 2 Waterbodies Impacted for Pathogens

Waterbody ID	Impacted Waterbody	Partially Supporting Desig. Uses [mi.]	Not Supporting Desig. Uses [mi.]
TN08010205003	SFFDR - Sumrow Cr. to Nixon Cr.	40.6	—
TN08010205010	SFFDR - Nixon Cr. to Mud Cr.	86.7	—
TN08010205012	SFFDR - Mud Cr. to Meridian Cr. (incl. Panther Cr., Central Cr., & Sandy Cr.)	238.3	9.7
TN08010205015	Johnson Creek	55	—
TN08010205028	North Fork of the SFFDR	17.5	—

4.0 TARGET IDENTIFICATION

Of the use classifications with numeric criteria for fecal coliform bacteria, the recreation use classification is the most stringent and will be used as the target level for TMDL development. The fecal coliform water quality criteria for protection of the recreation use classification, as established by *State of Tennessee Water Quality Standards, Chapter 1200-4-3 General Water Quality Criteria, October, 1999*. Section 1200-4-3-.03 (4) (f) states, in part, that the concentration of the fecal coliform group shall not exceed 200 per 100 ml as a geometric mean based on a minimum of 10 samples collected from a given sampling site over a period of not more than 30 consecutive days with individual samples being collected at intervals of not less than 12 hours. In addition, the concentration of the fecal coliform group in any individual sample shall not exceed 1,000 per 100 ml. The geometric mean standard is the target value for the TMDLs. A margin of safety of 20 counts/100 ml is included in the TMDLs.

5.0 WATER QUALITY ASSESSMENT AND DEVIATION FROM TARGET

With respect to fecal coliform, the existing water quality of 303(d) listed streams in the SFFDR watershed can be characterized by data collected since 1989 at following monitoring sites:

- STORET Station SFKFKDEER019.1 - SFFDR at Highway 88 (RM 19.7)
- STORET Station No. 002500 - SFFDR at Highway 54 (RM 30.6)
- STORET Station No. 002487 - SFFDR at Roberts Station Rd. (RM 43.2)
- Johnson Creek at Lower Brownsville Road
- North Fork of the SFFDR at Mifflin Road

Although insufficient data were collected to calculate 30-day geometric mean values, individual samples exceeded 1,000-counts/100 ml maximum at all sites except Highway 88 (see Table 3). Therefore, the three segments of South Fork Forked Deer River, Johnson Creek, and North Fork were listed as partially supporting designated uses and were scheduled for TMDL evaluation. Due to limited precipitation data available for use in the model, only data collected through December 1998 were used in the water quality calibration.

6.0 SOURCE ASSESSMENT

An important part of the TMDL analysis is the identification of source categories, source subcategories, or individual sources of fecal coliform bacteria in the watershed and the amount of pollutant loading contributed by each of these sources. Sources are broadly classified as either point or non-point sources.

A point source can be defined as a discernable, confined, and discrete conveyance from which pollutants are or may be discharged to surface waters. Point source discharges of industrial wastewater and treated sanitary wastewater must be authorized by National Pollutant Discharge Elimination System (NPDES) permits. NPDES permitted facilities discharging treated sanitary wastewater are considered primary point sources of fecal coliform bacteria.

Non-point sources of fecal coliform bacteria are diffuse sources that cannot be identified as entering a waterbody through a discrete conveyance at a single location. These sources generally, but not always, involve accumulation of fecal coliform bacteria on land surfaces and washoff as a result of storm events. Typical non-point sources of fecal coliform bacteria include:

- Wildlife
- Land application of agricultural manure
- Livestock grazing
- Leaking septic systems
- Urban development (including leaking sewer collection lines)
- Animals having access to streams

6.1 Point Sources

There are a number of point sources located in the drainage areas of the 303(d) listed stream segments that possess NPDES permits for discharges of treated sanitary wastewater. The average flow and fecal coliform loading, as reported on Discharge Monitoring Reports (DMRs), for these facilities are summarized in Table 4.

Table 3 Water Quality Monitoring Data

Sample Date	Monitoring Site				
	SFFDR @ Hwy. 88	SFFDR @ Hwy. 54	SFFDR @ Robts. Sta. Rd.	Johnson Creek	North Fork of the SFFDR
	[#/100 ml]	[#/100 ml]	[#/100 ml]	[#/100 ml]	[#/100 ml]
2/8/89			10		
5/11/89			250		
8/8/89			600		
11/7/89			330		
1/2/90			800		
4/11/90			410		
6/5/90			630		
9/5/90			720		
11/7/90			200		
1/3/91			240		
5/1/91			420		
7/2/91			510		
10/7/91			1,500		
12/11/91	980				
1/21/92			32		
4/22/92			240		
1/27/93	370				
1/24/96	800				
5/20/97					37,000
5/21/97					5,000
5/22/97					840
6/10/97		1,100	2,900	230	
6/11/97		16,000	21,000	16,000	
6/12/97		3,800	2,400	8,900	
10/14/97					3,400
10/15/97					780
10/16/97					170
10/21/97		270	700	270	
10/22/97		860	1,200	16	
10/23/97		820	1,500	57	
3/24/99		650			
6/9/99		260			
9/28/99		240			
12/1/99		210			

Table 4 NPDES Facilities Discharging Fecal Coliform in the South Fork Forked Deer River Watershed

Facility Name	NPDES Permit No.	Discharge Monitoring Reports: Flow [cfs]	Discharge Monitoring Reports: Fecal Coliform Loading[a] [counts/hr]	NPDES Permit: Design Flow [cfs]	NPDES Permit: Fecal Coliform Loading [b] [counts/hr]
Beech Bluff School	TN0023272	0.0035	3.540×10^4	0.008	1.577×10^6
Pinson UD STP	TN0067083	0.0232	2.367×10^6	0.062	1.262×10^7
Henderson North Lagoon	TN0064220	0.1052	5.579×10^6	0.727	1.483×10^8
Henderson South Lagoon	TN0064238	0.2135	1.198×10^7	0.928	1.893×10^8
Henderson East Lagoon	TN0026026	0.0511	2.627×10^6	0.309	6.309×10^7
West Sr. High School	TN0023311	0.0144	1.465×10^5	0.019	3.943×10^6
Denmark School	TN0056472	0.0013	1.335×10^4	0.025	5.047×10^6
Jackson UD STP	TN0024813	15.68	1.572×10^8	26.92	5.489×10^9
Bells Lagoon	TN0026247	0.1533	3.118×10^7	4.254	8.675×10^8
Wilhite's 76 Truck Stop	TN0022519	0.022	1.580×10^7	0.033	6.813×10^6
Econolodge	TN0023230	0.011	5.248×10^7	0.031	6.309×10^6 [c]
Ports Petroleum	TN0060151	0.006	1.220×10^6	0.018	3.722×10^6
Maury City Lagoon	TN0065218	0.024	4.877×10^6	0.232	4.732×10^7
Brownsville STP (Future)	Planning Limits	NA	NA	3.527	7.192×10^8

a Loadings based on average fecal coliform concentration and mean flow reported on DMRs.
b Loading based on Monthly Average permit limit (200 counts/ 100 ml) at design flow.
c Loading based on average concentration reported on 1995 permit application.

6.2 Nonpoint Source Assessment

6.2.1 Wildlife

Wildlife deposit fecal coliform bacteria with their feces onto land surfaces where it can be transported during storm events to nearby streams. Deer densities for several counties in the SFFDR watershed provided by the Tennessee Wildlife Resources Agency (TWRA), range from 18 to 32 animals per square mile. Fecal coliform loading due to deer is estimated by EPA to be 5.0×10^8 counts/animal/day.

6.2.2 Agricultural Animals

Agricultural animals are the source of several types of fecal coliform loading to streams in the SFFDR watershed:

- As with wildlife, agricultural livestock grazing on pastureland or forestland deposit fecal coliform bacteria with their feces onto land surfaces where it can be transported during storm events to nearby streams.

- Processed agricultural manure from confined feeding operations is generally collected in lagoons and applied to land surfaces during the months April through October. In the SFFDR watershed, manure is applied only to pastureland since chemical fertilizer is used on cropland. Data sources for animal feeding operations are tabulated by county and include the Census of Agriculture (USDA, 1997) and the Natural Resources Conservation Service (NRCS).

- Agricultural livestock and other unconfined animals (i.e., deer and other wildlife) often have direct access to streams that pass through pastures. In Haywood County, cattle do not have access to streams due to stream banks being steep and highly erodible (NRCS provided information).

Livestock data for the three major counties in the SFFDR watershed are listed in Table 5. Beef cows and swine are the predominate livestock in the watershed. Fecal coliform loading rates for livestock in the watershed are estimated to be: 1.06×10^{11} counts/day/beef cow, 1.24×10^{10} counts/day/hog, and 4.18×10^{8} counts/day/horse (NCSU, 1994).

Table 5 Livestock Distribution By County

Livestock	Haywood Co.	Madison Co.	Chester Co.
Poultry	0	0	0
Dairy	0	0	0
Beef	4000	5920	4330
Swine	1100	7588	1000
Horses	150	824	215

6.2.3 Failing Septic Systems

Some fecal coliform loading in the SFFDR watershed can be attributed to failure of septic systems and illicit discharges of raw sewage. Estimates from county census data of people in selected SFFDR subwatersheds utilizing septic systems are shown in Table 6. In western Tennessee, EPA estimates that there are approximately 2.5 people per household on septic systems, some of which can be reasonably assumed to be failing.

Table 6 Estimated Number of Septic Systems at Select Locations in South Fork Forked Deer River Watershed

Subwatershed	No. of Septic Systems
North Fork of the South Fork Forked Deer River	2750
Johnson Creek	775
South Fork Forked Deer River (for all subwatersheds above Station 002487, excluding North Fork and Johnson Cr. segments)	3180
South Fork Forked Deer River (for subwatersheds between Station 002487 and confluence of Sumrow Creek)	8142

6.2.4 Urban Development

Fecal coliform loading from urban areas is potentially attributable to multiple sources including storm water runoff, leaks and overflows from sanitary sewer systems, illicit discharges of sanitary waste, runoff from improper disposal of waste materials, leaking septic systems, and domestic animals. Urban runoff and storm water processes are considered to be significant contributors to fecal coliform impairment in some SFFDR subwatersheds.

7.0 ANALYTICAL APPROACH

Establishing the relationship between in-stream water quality and source loading is an important component of TMDL development. It allows the determination of the relative contribution of sources to total pollutant loading and the evaluation of potential changes to water quality resulting from implementation of various management options. This relationship can be developed using a variety of techniques ranging from qualitative assumptions based on scientific principles to numerical computer modeling. In this section, the numerical modeling techniques developed to simulate fecal coliform bacteria fate and transport in the watershed are discussed.

7.1 Model Selection

A dynamic computer model was selected for fecal coliform analysis in order to: a) simulate the time varying nature of fecal coliform bacteria deposition on land surfaces and transport to receiving waters; b) incorporate seasonal effects on the production and fate of fecal coliform bacteria; and c) identify the critical condition for the TMDL analysis. Several computer based tools were also utilized to generate input data for the model.

The Nonpoint Source Model (NPSM) is a watershed model capable of simulating nonpoint source runoff and associated pollutant loadings, account for point source discharges, and performing flow and water quality routing through stream reaches. NPSM is based on the Hydrologic Simulation Program - Fortran (HSPF). In these TMDLs, NPSM was used to simulate point source discharges, simulate the deposition and transport of fecal coliform bacteria from land surfaces, and compute the resulting water quality response. In-stream decay of fecal coliform bacteria as reported in Lombardo (1972) ranges from 0.008 to 0.13 per hour (1/hr), with a median value of 0.048 1/hr. In the model, in-stream decay was conservatively estimated using the median value.

In addition to NPSM, the Watershed Characterization System (WCS), a geographic information system (GIS) tool, was used to display, analyze, and compile available information to support water quality model simulations for the SFFDR watershed. This information includes land use categories, point source dischargers, soil types and characteristics, population data (human and livestock), and stream characteristics. Results of the WCS characterization are input to a spreadsheet developed by Tetra Tech, Inc. (see Appendix A) to estimate NPSM input parameters associated with fecal coliform buildup (loading rates) and washoff from land surfaces. In addition, the spreadsheet can be used to estimate direct sources of fecal coliform loading to water bodies from leaking septic systems and animals having access to streams. Information from the WCS and spreadsheet tools were used as <u>initial</u> input for variables in the NPSM model.

7.2 Model Set Up

The South Fork Forked Deer River watershed was delineated into 29 subwatersheds in order to characterize relative fecal coliform bacteria contributions from significant contributing drainage areas (see Figure 3). Boundaries were constructed so that subwatershed “pour points” coincided, when possible, with water quality monitoring stations or USGS flow gages. Watershed delineation was based on the Reach File 3 (Rf3) stream coverage and Digital Elevation Model (DEM) data. This discretization allows management and load reduction alternatives to be varied by subwatershed.

An important factor influencing model results is the precipitation data contained in the meteorological data file used in the simulation. The pattern and intensity of rainfall affects the build-up and wash-off of fecal coliform bacteria from the land into the streams, as well as the dilution potential of the stream. Weather data from the Memphis meteorological station were used for simulations in all subwatersheds.

7.3 Model Calibration

Calibration of the watershed model included both hydrology and water quality components. The hydrology calibration was performed first and involved adjustment of the model parameters used to represent the hydrologic cycle until acceptable agreement was achieved between simulated flows and historic stream flow data from a USGS stream gaging station in the watershed for the same period of time. Model parameters adjusted include: evapotranspiration, infiltration, upper and lower zone storage, groundwater storage, recession, losses to the deep groundwater system, and interflow discharge. USGS gages on the SFFDR near Gates (USGS Station 07027800) and at Jackson, Tennessee (USGS Station 07027500) were used for flow calibration.

The model was also calibrated for water quality. Appropriate model parameters were adjusted to obtain acceptable agreement between simulated in-stream fecal coliform concentrations and observed data collected at sampling stations in SFFDR, Johnson Creek, and North Fork of the

SFFDR. Results show that the model adequately simulated peaks in fecal coliform bacteria in response to storm events and base concentrations during low flow events.

After calibration was complete, a sensitivity analysis was performed to evaluate the model response to changes in input water quality and flow parameters. The model was considered sensitive to a parameter if a small change resulted in a large change in simulated flow or concentration.

The details and results of the hydrologic and water quality calibrations, as well as the sensitivity of the model to changes in animal access to streams, are presented in Appendix B.

8.0 DEVELOPMENT OF TOTAL MAXIMUM DAILY LOAD

The TMDL process quantifies the amount of a pollutant that can be assimilated in a waterbody, identifies the sources of the pollutant, and recommends regulatory or other actions to be taken to achieve compliance with applicable water quality standards based on the relationship between pollution sources and in-stream water quality conditions. A TMDL can be expressed as the sum of all point source loads (Waste Load Allocations), nonpoint source loads (Load Allocations), and an appropriate margin of safety (MOS) which takes into account any uncertainty concerning the relationship between effluent limitations and water quality:

$$\text{TMDL} = \Sigma \text{ WLAs} + \Sigma \text{ LAs} + \text{MOS}$$

The objective of a TMDL is to allocate loads among all of the known pollutant sources throughout a watershed so that appropriate control measures can be implemented and water quality standards achieved. 40 CFR §130.2 (i) states that TMDLs can be expressed in terms of mass per time (e.g. pounds per day), toxicity, or <u>other appropriate measure</u>.

8.1 Critical Conditions

The critical condition for non-point source fecal coliform loading is an extended dry period followed by a rainfall runoff event. During the dry weather period, fecal coliform bacteria builds up on the land surface, and has the potential to be transported by rainfall runoff. The critical condition for point source loading occurs during periods of low stream flow when dilution is minimized. Both conditions are simulated in the water quality model.

The ten-year period from January 1, 1989, to December 31, 1998 was used to simulate a continuous 30-day geometric mean concentration to compare to the target. This 10-year period contained a range of hydrological conditions that included both low and high stream flows from which critical conditions were identified and used to derive the TMDL values.

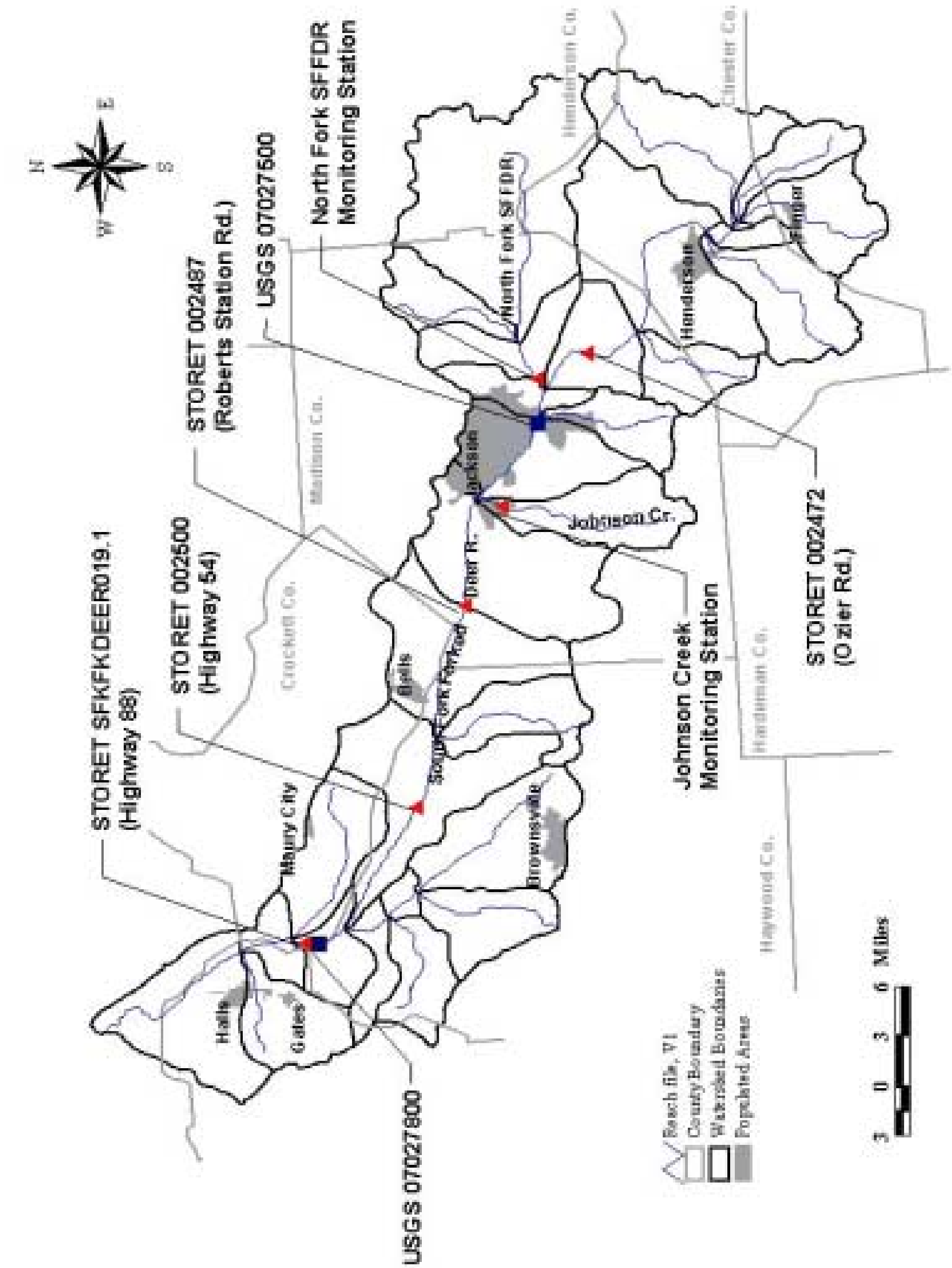


Figure 3 South Fork Forked Deer River Watershed

The ten-year simulated geometric mean concentrations for existing conditions are presented in Appendix C. From these figures, critical conditions can be determined. The 30-day critical period in the model is the period preceding the largest simulated violation of the geometric mean standard (EPA, 1991). Meeting water quality standards during this period ensures that water quality standards can be achieved throughout the ten-year period. For the listed segments in the South Fork Forked Deer River watershed, the highest violation of the 30-day geometric mean occurred on July 19, 1998. The critical period then, is June 20, 1998 through July 19, 1998.

8.2 Existing Conditions

The existing fecal coliform load for each of the 303(d) listed waterbodies in the SFFDR watershed was determined in the following manner:

- The calibrated model, corresponding to the portion of the SFFDR watershed that is upstream of the pour point of the listed waterbody segment was run for a time period that included the critical condition (6/20/98 – 7/19/98).

- The daily fecal coliform load indirectly going to surface waters from all land uses was added to the direct daily discharge load of modeled point sources and the result summed for the 30 day critical period. This value represents the existing load.

Model results indicate that non-point sources related to agricultural and urban land uses are the largest sources of fecal coliform bacteria loading in the SFFDR watershed. Direct inputs of fecal coliform bacteria from “other sources” (i.e., animal access to streams, illicit discharges of fecal coliform bacteria, failing septic systems, and leaking sewer collection lines) are also shown to have an impact on bacteria loading in the watershed. Reductions in these loading rates reduce the in-stream fecal coliform bacteria levels. Non-point source loading rates, and the geometric mean in-stream concentration simulated during the critical period, representing existing conditions in the model are shown in Table 7.

In general, point source loads from NPDES facilities do not significantly contribute to the impairment of the listed stream segments since discharges from these facilities are required to be treated to levels corresponding to in-stream water quality criteria. However, two NPDES facilities in the watershed, Wilhite’s 76 Truck Stop (TN0022519) and Econolodge (TN0023230), have discharges above permit limits and contribute to impairment of SFFD between the confluence of Mud Creek to Meridian Creek. Reductions in the loading rates from these facilities are required to reduce in-stream fecal coliform bacteria levels. Table 4 provides point source loads from NPDES facilities for existing conditions based on DMRs (see Table 4, note c) and loads for TMDL conditions based on facility design flows and permit limits. As shown in this table, with the exception of Wilhite’s 76 Truck Stop and Econolodge, existing loads for all facilities are significantly lower than the load at the permit limits.

Table 7 Nonpoint Source Loading Rates and In-stream Fecal Coliform Bacteria Concentrations for Existing Conditions

Subwatershed	Runoff from All Lands	Other Direct Sources	In-stream Fecal Coliform Bacteria Concentration[1]
	[Counts / 30 days]	[Counts / 30 days]	[Counts / 100 ml]
SFFDR @ confluence of Sumrow Cr. (includes all modeled areas)	$1.20x\ 10^{15}$	1.69×10^{13}	274.05
SFFDR @ confluence of Nixon Cr.	1.04×10^{15}	1.62×10^{13}	272.33
SFFDR @ confluence of Mud Cr.	1.00×10^{15}	1.59×10^{13}	563.24
Johnson Creek	1.44×10^{13}	6.26×10^{11}	682.15
North Fork of the SFFDR	2.48×10^{13}	7.61×10^{12}	478.06

1. Fecal coliform bacteria concentrations represent the maximum simulated geometric mean concentration during the critical period (see Section 8.1).

8.3 Margin of Safety

There are two methods for incorporating an MOS in the analysis: a) implicitly incorporate the MOS using conservative model assumptions to develop allocations; or b) explicitly specify a portion of the TMDL as the MOS and use the remainder for allocations. In these TMDLs, both an explicit and implicit MOS were used. The explicit MOS is 20 counts/100 ml below the in-stream target concentration on all reaches. The implicit MOS includes the use of conservative modeling assumptions and a 10-year continuous simulation that incorporates a range of meteorological events. Conservative modeling assumptions used include: septic systems discharging directly into the streams; development of the TMDL using loads based on the design flow and fecal coliform permit limits of NPDES facilities; all land uses connected directly to streams; negligible decay of fecal coliform bacteria once manure is applied on the land; and a conservative estimate of in-stream decay of fecal coliform bacteria in the waterbodies.

8.4 Determination of TMDL, WLAs, & LAs

The TMDL is the total amount of pollutant that can be assimilated by a water body while maintaining water quality standards. Fecal coliform bacteria TMDLs are expressed as counts per 30 day period since this is how the water quality standard is expressed. The TMDL, therefore, represents the maximum fecal coliform bacteria load that can be assimilated by a stream during the critical 30-day period while maintaining fecal coliform bacteria levels at concentrations less than the water quality standard of 200 counts/100 ml.

The TMDL components were estimated according to the following procedure:

- The calibrated model, corresponding to the portion of the SFFDR watershed that is upstream of the pour point of the listed waterbody segment was run for a time period that included the critical condition (6/20/98 – 7/19/98).

- Existing NPDES permitted facilities and known future facility discharges were assumed to discharge at design flows and the fecal coliform permit limit of 200 counts/100 ml. Wilhite's 76 Truck Stop and Econolodge were assumed to have reduced discharge loading so as to be in compliance with their permits.

- Fecal coliform land loading variables and the magnitude of loading from sources modeled as "other direct sources" were adjusted within reasonable range of known values until the resulting fecal coliform concentration at the pour point of the listed water body segment is less than 180 counts/100 ml (water quality standard of 200 counts/100ml minus 20 counts/100 ml explicit MOS).

- The $\sum$WLAs is the load associated with the daily discharge loads of all modeled NPDES permitted facilities summed over the 30 day critical period. The discharge load for each facility represents the design flow at the permitted fecal coliform concentration of 200 counts/100 ml.

- The $\sum$LAs is the daily fecal coliform load indirectly going to surface waters from all modeled land use areas as a result of buildup/washoff processes plus the daily discharge load sources modeled as "other direct sources" and the result summed over the 30 day critical period.

- The percent reduction is based on the maximum simulated geometric mean concentrations for the 30-day critical period for existing and TMDL conditions. The maximum simulated concentrations for the TMDL scenario ranged between 110 and 180 counts/100 ml.

The TMDL components for the listed water bodies are summarized in Table 8.

Table 8 TMDL Components

Watershed	∑WLAs [counts/30 day]	∑LAs [counts/30 day]	TMDL [counts/30 day]
SFFDR at confluence of Sumrow Cr. (includes all areas)	5.45×10^{12}	2.55×10^{14}	2.60×10^{14}
SFFDR at confluence of Nixon Cr.	5.45×10^{12}	1.78×10^{14}	1.83×10^{14}
SFFDR at confluence of Mud Cr.	4.89×10^{12}	1.59×10^{14}	1.64×10^{14}
Johnson Creek	6.47×10^{9}	2.38×10^{12}	2.39×10^{12}
North Fork of the SFFDR	1.14×10^{9}	8.99×10^{12}	8.99×10^{12}

8.4.1 Waste Load Allocations

There are 13 NPDES permitted facilities and one future facility that discharge fecal coliform bacteria in the South Fork Forked Deer River watershed. Reductions of 81% from Wihlite's 76 Truck Stop and Econolodge, corresponding to discharges at design flow and permit limits, are required as part of the TMDL. Future facility permits will require end-of-pipe limits equivalent to the water quality standard of 200-counts/100 ml.

8.4.2 Load Allocations

There are two modes of transport for non-point source fecal coliform bacteria loading in the model. First, loading from failing septic systems, animals in the stream, and leaking sewer system collection lines are modeled as "other direct sources" to the stream and are independent of precipitation. The second mode involves loading resulting from the transport of fecal coliform in runoff during storm events. Fecal coliform applied to land is subject to a die-off rate and an absorption rate before it is transported to the stream.

Model results indicate that non-point sources related to agricultural and urban runoff and direct inputs have the greatest impact on the fecal coliform bacteria loadings in the SFFDR watershed. One possible allocation scenario that would meet in-stream water quality standards for the listed streams in the SFFDR watershed includes (Note: in-stream fecal coliform reduction includes the effects of dilution and decay):

- North Fork of the SFFDR: 76% load reduction from runoff and 60% load reduction from "other direct sources" of fecal coliform bacteria in the stream, resulting in an in-stream fecal coliform reduction of 62%.

- Johnson Creek: 85% load reduction from runoff and a 55% load reduction from "other direct sources" of fecal coliform bacteria in the stream, resulting in an in-stream fecal coliform reduction of 74%.

- South Fork Forked Deer at confluence of Mud Creek: 85% load reduction from runoff and 56% load reduction from "other direct sources" of fecal coliform bacteria in the stream, resulting in an in-stream fecal coliform reduction of 67%.

- South Fork Forked Deer between confluence of Nixon and Mud Creeks: 84% load reduction from runoff and a 55% load reduction from "other direct sources" of fecal coliform bacteria in the stream, resulting in an in-stream fecal coliform reduction of 34%.

- South Fork Forked Deer between confluence of Nixon and Sumrow Creeks: 80% load reduction from runoff and a 55% load reduction from "other direct sources" of fecal coliform bacteria in the stream, resulting in an in-stream fecal coliform reduction of 34%.

Best management practices (BMPs) that could be used to implement this TMDL include controlling pollution from agriculture and urban runoff, identification and elimination of illicit discharges and other unknown "direct sources" of fecal coliform bacteria to the streams, and repair of leaking sewer collection lines and failing septic systems. Loading from agricultural sources should be minimized by adoption of NRCS resource management practices. NRCS practices include measures such as covering manure stacks exposed to the environment; reducing animal access to streams; and applying manure to pasture/hay lands and croplands at agronomic rates. Fecal coliform loading rates and the percent reduction of in-stream fecal coliform bacteria concentrations required to achieve water quality standards for this allocation scenario are shown in Table 9. Additional monitoring and characterization of the watershed should be conducted to verify the various other direct sources of fecal coliform bacteria in the watershed.

Table 9 Load Allocations South Fork Forked Deer River Watershed

Watershed	Runoff Load	Load from "Other Direct Sources"	Overall In-stream Reduction (Existing to Allocated Conditions)[1]
	[counts/30 days]	[counts/30 days]	[%]
South Fork Forked Deer R. @ confluence of Sumrow Cr.	2.47×10^{14}	7.64×10^{12}	34
South Fork Forked Deer R. @ confluence of Nixon Cr.	1.71×10^{14}	7.23×10^{12}	34
South Fork Forked Deer R. @ confluence of Mud Cr.	1.51×10^{14}	7.06×10^{12}	67
Johnson Creek	2.10×10^{12}	2.80×10^{11}	74
North Fork of the South Fork Forked Deer River	5.89×10^{12}	3.09×10^{12}	62

1. The percent reduction of <u>in-stream</u> fecal coliform bacteria concentrations based on the simulated geometric mean concentration for existing conditions and the target concentration of 180 counts/100 ml.

8.4.3 Seasonal Variation

Seasonal variation was incorporated in the continuous simulation water quality model by using varying monthly loading rates and daily meteorological data.

9.0 IMPLEMENTATION PLAN

The TMDL analysis was performed using the best data available to specify WLAs & LAs that will meet the water quality criteria for pathogens (fecal coliform) in South Fork Forked Deer River watershed so as to support its Recreation use classification. The following recommendations and strategies are targeted toward source identification, collection of data to support additional modeling and evaluation, and subsequent reduction in sources that are causing impairment of water quality.

9.1 Point Source Facilities

All discharges from point source facilities are required to be in compliance with the conditions of their NPDES permit at all times.

9.2 Urban Sources of Fecal Coliform Loading

The City of Jackson and Madison County will be issued NPDES Municipal Separate Storm Sewer System (MS4) permits under the Phase 2 storm water regulations. Applications are due by March 10, 2003. Each permitted entity will be required to develop a Storm Water Management Program (SWMP). The SWMP covers the duration of the permit (5-year renewable) and comprises a comprehensive planning process which involves public participation and intergovernmental coordination to reduce the discharge of pollutants to the maximum extent practicable using management practices, control techniques, public education, and other appropriate methods and provisions. With respect to fecal coliform pollution reduction, additional activities and programs conducted by city, county, and state agencies are recommended to support the SWMP:

- Field screening and monitoring programs to identify the types and extent of fecal coliform water quality problems, relative degradation or improvement over time, areas of concern, and source identification.

- Requirements that all new and replacement sanitary sewage systems are designed to minimize discharges from the system into the storm sewer system.

- Mechanisms for reporting and correcting illicit connections, breaks, surcharges, and general sanitary sewer system problems with potential to release to the municipal separate storm sewer system.

- Require NPDES facilities to comply with permit limits.

9.3 Agricultural Sources of Fecal Coliform Loading

The Tennessee Department of Environment & Conservation (TDEC) should coordinate with the Tennessee Department of Agriculture (TDA) and the Natural Resources Conservation Service (NRCS) to address issues concerning fecal coliform loading from agricultural land uses in the South Fork Forked Deer River watershed. It is recommended that additional information (such as livestock populations by subwatershed, animal access to streams, manure application practices, etc.) be evaluated to better identify and quantify agricultural sources of fecal coliform loading in order to minimize uncertainty in future modeling efforts. It is further recommended that BMPs be utilized to reduce the amount of fecal coliform bacteria transported to surface waters from agricultural sources to the maximum extent practicable.

9.4 Stream Monitoring

Tennessee's watershed management approach specifies a five-year cycle for planning and assessment. Each watershed will be examined (or re-examined) on a rotating basis. Generally, in years two and three of the five-year cycle, water quality data are collected in support of water quality assessment (including TMDL development) and planning activities. Therefore, a watershed TMDL is developed one to two years prior to commencement of the next cycle's monitoring period.

Continued monitoring of the fecal coliform concentration at multiple water quality sampling points in the watershed is critical in characterizing sources of fecal coliform contamination and documenting future reduction of loading. In the next watershed cycle, monitoring should be expanded to provide water quality information to characterize seasonal trends and refined source identification and delineation. Recommended monitoring for the SFFDR watershed includes monthly grab samples and intensive sampling for one month during the wet season (January-March). In addition, monitoring efforts should be refined and enhanced in order to characterize dry and wet season base flow conditions (concentrations) and promote selective storm response (hydrograph) characterization. Lastly, stream discharge should be measured or estimated with the collection of each fecal coliform sample to characterize the dynamics of fecal coliform transport within the surface-water system.

9.5 Future Efforts

This TMDL represents the first phase of a long-term restoration project to reduce fecal coliform loading to acceptable levels (meeting water quality standards) in the South Fork Forked Deer River watershed. TDEC, coordinating with the TDA, will evaluate the progress of implementation strategies and refine the TMDL as necessary in the next phase (next five-year cycle). This will include recommending specific implementation plans for identified problem areas with as yet undefined sources and causes of pollution. Cooperation will be maintained with TDA (for possible 319 non-point source grants) and NRCS for developing BMPs. The dynamic loading model may be upgraded and refined in the next phase to more effectively link sources (including background and agricultural) to impacts and characterize the processes (loading, transport, decay, etc.) contributing to exceedances of fecal coliform concentrations (loading) in impacted water bodies. The phased approach will assure progress toward water quality standards attainment in the future.

10.0 PUBLIC PARTICIPATION

In accordance with 40 CFR §130.7, announcement of the availability of proposed fecal coliform TMDLs for three sections of SFFDR (Sumrow Creek to Nixon Creek, Nixon Creek to Mud Creek, & Mud Creek to Meridian Creek), Johnson Creek, and the North Fork of the SFFDR was made to the public, effected dischargers, and other concerned parties and comments solicited. Steps taken in this regard include:

1) Notice of the proposed TMDLs was posted on the Tennessee Department of Environment and Conservation website on March 5, 2001 (see Appendix D). The announcement invited public comment until April 30, 2001.

2) Notice of the availability of the proposed TMDLs (similar to the website announcement) was included in one of the NPDES permit Public Notice mailings which are sent to approximately 90 interested persons or groups who have requested this information.

3) A Legal Notice, similar to the website announcement, was published in the classified section of the following Tennessee newspapers on, or near, the dates indicated:

   The Jackson Sun - March 29, 2001
   The Knoxville News-Sentinel - March 9, 2001)
   The Commercial Appeal (Memphis) – March 29, 2001
   The Tennessean (Nashville) – March 12, 2001

4) A letter was sent to point source facilities in the SFFDR study area that are permitted to discharge treated sanitary wastewater advising them of the proposed fecal coliform TMDLs and their availability on the TDEC website. The letter also stated that a written copy of the draft TMDL document would be provided on request. Letters were sent to the following facilities:

   Beech Bluff School (TN0023272)
   Pinson Utility District STP (TN0067083)
   Henderson North Lagoon (TN0064220)
   Henderson South Lagoon (TN0064238)
   Henderson East Lagoon (TN0026026)
   West Sr. High School (TN0023311)
   Denmark School (TN0056472)
   Jackson Utility District STP (TN0024813)
   Bells Lagoon (TN0026247)
   Wilhite's 76 Truckstop (TN0022519)
   Scottish Inn (TN0023230)
   Ports Petroleum (TN0060151)
   Maury City Lagoon (TN0065218)
   Brownsville STP (Planning Limits)

5) A draft copy of the proposed fecal coliform TMDLs was sent to the City of Jackson and Madison County. Both of these entities will be issued Municipal Separate Storm Sewer System (MS4) permits under the Phase II storm water regulations.

6) A meeting was held in Jackson on April 19, 2001 to explain the assumptions and modeling methodologies used to develop the TMDLs. Meeting participants included personnel from EPA and Division of Water Pollution Control and representatives from the agricultural community.

Written comments were received from one party during the public comment period. These comments are included in Appendix E and the Division of Water Pollution Control responses are contained in Appendix F. No requests to hold public meetings were received regarding the proposed TMDLs as of close of business on April 30, 2001.

11.0 FURTHER INFORMATION

Further information concerning Tennessee's TMDL program can be found on the Internet at the Tennessee Department of Environment and Conservation website:

www.state.tn.us/environment/wpc/tmdl.htm

Technical questions regarding <u>this</u> TMDL should be directed to the following members of the Division of Water Pollution Control staff:

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APPENDIX A

Example of Runoff Load Calculation Spreadsheet

EXAMPLE CALCULATION OF RUNOFF LOAD (example shown for runoff from pastureland in Chester Co)

COUNTY	AGRICULTURAL ANIMALS (NRCS and WWW.NASS.GOV for horses)								
	CATTLE	BEEF	DAIRY	SWINE	SHEEP	BROILERS	LAYERS	HORSES	cattle access to stream
Chester	8608	4330	0	1000	10	0	0	215	yes
Madison	13864	5920	16	7588	45	38	0	824	no
Haywood	6220	4000	0	1100	2	0	245	150	no

LOAD ESTIMATES BASED ON ANIMAL POPULATION AND LAND APPLICATION OF MANURE
Runoff from pastureland (COUNTS/DAY) = Number animals * Fecal concentration (counts/animal/day) * Fecal content multiplier * Runoff rate * monthly application rate
Model units are in terms of counts/acre-day and are calculated by dividing the load by the area of pasture land in the county (calculation not shown)

Hog Manure Available for Wash-off
Fecal concentration 1.24E+10 counts/animal/day (NCSU, 1994)
Manure fecal content multiplier 0.75 (assume 25% dies-off in lagoon - EPA conservative assumption)
Fraction available for runoff 0.63 (EPA assumption)
Hog manure application rates (NRCS):

	January	February	March	April	May	June	July	August	September	October	November	December
Fraction of manure applied each month	0	0	0.075	0.1575	0.1335	0.1335	0.1335	0.1335	0.1585	0.075	0	0
Hog manure runoff from pastureland (counts/day):												
Chester Co	0.00E+00	0.00E+00	4.39E+11	9.21E+11	7.81E+11	7.81E+11	7.81E+11	7.81E+11	9.27E+11	4.39E+11	0.00E+00	0.00E+00

Beef Cattle Manure Available for Wash-off
Fecal concentration 1.06E+11 counts/animal/day (NCSU, 1994)
Manure fecal content multiplier 1 (a value of 1 assumes fresh application - worse case scenario)
Fraction available for runoff 0.6 (EPA assumption)
Beef cattle manure application rates (NRCS):

	January	February	March	April	May	June	July	August	September	October	November	December
Fraction of manure applied each month	0.0833	0.0833	0.0833	0.0833	0.0833	0.0834	0.0834	0.0834	0.0834	0.0833	0.0833	0.0833
Beef manure runoff from pastureland (counts/day):												
Chester Co	2.30E+13	2.30E+13	2.30E+13	2.30E+13	2.30E+13	2.30E+13	2.30E+13	2.30E+13	2.30E+13	2.30E+13	2.30E+13	2.30E+13

Horse Manure Available for Wash-off
Fecal concentration 4.18E+08 counts/animal/day (NCSU, 1994)
Manure fecal content multiplier 0.75 (a value of 1 assumes fresh application - worse case scenario)
Fraction available for runoff 0.63 (EPA assumption)
Horse manure application rates (NRCS):

	January	February	March	April	May	June	July	August	September	October	November	December
Fraction of manure applied each month	0.0833	0.0833	0.0833	0.0833	0.0833	0.0834	0.0834	0.0834	0.0834	0.0833	0.0833	0.0833
Horse manure runoff from pastureland (counts/day):												
Chester Co	3.54E+09	3.54E+09	3.54E+09	3.54E+09	3.54E+09	3.54E+09	3.54E+09	3.54E+09	3.54E+09	3.54E+09	3.54E+09	3.54E+09

Runoff load from pastureland (counts/day)	January	February	March	April	May	June	July	August	September	October	November	December
from beef, swine, and horses - Chester Co.	2.30E+13	2.30E+13	2.34E+13	2.39E+13	2.38E+13	2.38E+13	2.38E+13	2.38E+13	2.40E+13	2.34E+13	2.30E+13	2.30E+13

Estimation of load from animal access to streams (for calculation purposes assume only beef cattle have access to streams)
assume 50 % of beef cattle in the watershed have access to streams and of those 25% defecate in or near the stream banks about 3 minutes per day
(resulting stream access is 0.00025 (i.e., 0.5 x 0.25 x 3min/(24*60))

Total load from cattle in stream =number beef cows in watershed * fecal concentration * 0.00025

APPENDIX B

Model Development and Calibration

B.1 Model Set Up

The South Fork Forked Deer River watershed was delineated into 29 subwatersheds in order to characterize relative fecal coliform bacteria contributions from significant contributing drainage areas (see Figure 3). Boundaries were constructed so that subwatershed “pour points” coincided, when possible, with water quality monitoring stations or USGS flow gages. Watershed delineation was based on the Rf3 stream coverage and Digital Elevation Model (DEM) data. This discretization allows management and load reduction alternatives to be varied by subwatershed. Initial input for model variables was developed using WCS and the associated spreadsheet tools.

An important factor influencing model results is the precipitation data contained in the meteorological data file used in the simulation. The pattern and intensity of rainfall affects the build-up and wash-off of fecal coliform bacteria from the land into the streams, as well as the dilution potential of the stream. Weather data from the Memphis meteorological station were available for the time period from January 1970 through December 1998 and were used for all simulations. The model was allowed to stabilize for one year (1988) before results from the 10-year simulation were analyzed.

B.2 Model Calibration

The calibration of the NPSM watershed model involves both hydrology and water quality components. The model must be calibrated to appropriately represent hydrologic response in the watershed before subsequent calibrations and reasonable water quality simulations can be performed. A sensitivity analysis is part of the calibration process to evaluate the impact model parameters have on the simulated results.

B.2.1 Hydrologic Calibration

The hydrology calibration of the watershed model involves comparing simulated stream flows to historic stream flow data from a USGS stream gaging station for the same period of time. The hydrology portion of the model was calibrated using two continuous USGS flow gages on the South Fork Forked Deer River: Station No. 07027500 at Jackson, Tennessee during the period from May 1, 1988 through September 30, 1990 and Station No. 07027800 located near Gates, Tennessee during the period from January 1, 1970 through December 31, 1981. The portion of the watershed modeled for the calibration simulations corresponds to the drainage area upstream of the appropriate USGS station.

Initial values for hydrological variables were taken from an EPA developed default data set. During the calibration process, model parameters were adjusted within reasonable constraints until acceptable agreement was achieved between simulated and observed stream flow. Model parameters adjusted include: evapotranspiration, infiltration, upper and lower zone storage, groundwater storage, recession, losses to the deep groundwater system, and interflow discharge. Results of the hydrology calibration for selected years are shown in Figures A-1 to A-4.

B.2.2 Water Quality Calibration

SFFDR watershed data, generated by WCS, was processed through the spreadsheet applications developed by Tetra Tech, Inc. to generate fecal coliform loading data for use as initial input to the NPSM model. The sensitivity of the model to changes in nonpoint source loading rates is a critical element of the calibration process. The model is very sensitive to loads applied directly into the stream (e.g., leaking septic systems, animal access to streams, etc.) and if the loads are too high, then the model will not accurately simulate the response to rainfall runoff.

B.2.2.1 Point Sources

For existing conditions, NPDES facilities located in modeled subwatersheds are represented as point sources of constant flow and concentration based on the facility's average flow and effluent fecal coliform concentration as reported on DMRs (see Table 4, note c).

B.2.2.2 Nonpoint Sources

A number of nonpoint source categories are not associated with land loading processes and are represented as direct, in-stream source contributions in the model. These may include, but are not limited to, failing septic systems, leaking sewer lines, animals in streams, direct discharge of raw sewage, and undefined sources. All other nonpoint sources involve land loading of fecal coliform bacteria and washoff as a result of storm events. Only a portion of the load from these sources are actually delivered to streams due to the mechanisms of washoff (efficiency), decay, and incorporation into soil (adsorption, absorption, filtering) before being transported to the stream. Therefore, land loading nonpoint sources are represented as indirect contributions to the stream. Buildup, washoff, and die-off rates are dependent on seasonal and hydrologic processes.

Initial input for nonpoint sources of fecal coliform loading in the water quality model was developed using watershed information generated with WCS and the Tetra Tech loading calculation spreadsheets.

B.2.2.2.1 Wildlife

Fecal coliform loading from wildlife is considered to be uniformly distributed to forest, pasture, cropland, and wetland areas in the modeled subwatersheds. A loading rate of 5.0×10^8 counts/animal/day for deer is based on best professional judgment (BPJ) of EPA. An animal density of 45 animals/square mile is used to account for deer and all other wildlife. The resulting fecal coliform loading is 2.5×10^6 counts/acre/day and is considered background.

B.2.2.2.2 Land Application of Agricultural Manure

In the water quality model, county livestock populations (see Table 5) are distributed to subwatersheds based on the percentage of agricultural area in each subwatershed classified as pasture/hay. Fecal coliform loading rates were calculated from livestock populations based on manure application rates, literature values for bacteria concentrations in livestock manure, and the following assumptions:

- Fecal content in manure was adjusted to account for die-off due to known treatment/storage methods.
- Manure application rates from the various animal sources vary monthly according to management practices. Hog manure is applied from March through September; beef cattle manure is applied throughout the year.

- The fraction of manure available for runoff is dependent on the method of manure application. In the water quality model, the fraction available is estimated based on incorporation into the soil.

- In western Tennessee, manure is not applied to cropland, only pastureland.

- Fecal coliform production rates used in the model for beef cattle, hogs, and horses are 1.06×10^{11} counts/day/beef cow, 1.24×10^{10} counts/day/hog, and 4.18×10^{8} counts/day/horse (NCSU, 1994).

Since manure is not applied to cropland in the SFFDR watershed, the only source of fecal coliform bacteria from cropland is from wildlife that deposits feces on the land surface. The in-stream loading from cropland is considered background.

B.2.2.2.3 Grazing Animals

Cattle spend time grazing on pastureland and deposit feces onto the land. During storm events, a portion of this material containing fecal coliform bacteria is transported to streams. Beef cattle are assumed to spend all their time in pasture. In Madison County, cattle also have access to forestland. The percentage of feces deposited during grazing time is used to estimate fecal coliform loading rates from pastureland. Because there is no assumed monthly variation in animal access to pastures (or forest land in Madison County) in western Tennessee, the fecal loading rate does not vary significantly throughout the year. Therefore, the loading rate to pastureland used in the model is assumed to be constant. This rate varies from 8×10^{9} counts/acre-day for subwatersheds in Haywood and Madison Counties to 1.0×10^{10} counts/acre-day for subwatersheds in Chester County. Contributions of fecal coliform from wildlife (as noted in Section A.2.2.2.1) are also included in these rates.

B.2.2.2.4 Urban Development

Urban land use represented in the MRLC database includes areas classified as: high intensity commercial, industrial, transportation, low intensity residential, high intensity residential, and transitional. Associated with each of these classifications a percent of the land area that is impervious. A single, area-weighted loading rate from urban areas is used in the model and is based on the percentage of each urban land use type in the watershed and build-up and accumulation rates referenced in Horner (1992). In the water quality calibrated model, this rate varies from 7.5×10^{9} to 2.5×10^{10} counts/acre-day and is assumed constant throughout the year.

B.2.2.2.5 Other Sources

As previously stated, there are a number of nonpoint sources of fecal coliform bacteria that are not associated with land loading and washoff processes. These include animal access to streams, failing septic systems, leaking sewer lines, illicit discharges, and other undefined sources. In each subwatershed, all of these miscellaneous sources have been grouped together and modeled as a point source of constant flow and fecal coliform concentration. The initial baseline values of flow and concentration were estimated using the Tetra Tech, Inc. developed spreadsheets and the following assumptions:

- The load attributed to animals having access to streams is initially based on the beef cow population in the watershed. It was assumed that 50 % have access to streams and, of those, 25% defecate in or near the stream banks during a portion of the day. The resulting percentage of time fecal coliform bacteria is discharged into the streams from grazing cattle is 0.025 percent. Literature values were used to estimate the fecal coliform bacteria concentration in beef cow manure.

- The initial baseline loads attributable to leaking septic systems is based on an assumed failure rate of 20 percent.

These flow and concentration variables were adjusted during water quality calibration to alter simulated in-stream fecal concentrations during dry weather conditions.

B.2.2.3 Water Quality Calibration Results

During water quality calibration, model parameters were adjusted within reasonable limits until acceptable agreement between simulation output and in-stream observed data was achieved. Model variables adjusted include:

- Rate of fecal coliform bacteria accumulation
- Maximum storage of fecal coliform bacteria
- Rate of surface runoff that will remove 90% of stored fecal coliform bacteria
- Concentration of fecal coliform bacteria in interflow
- Concentration of fecal coliform bacteria in groundwater
- Concentration of fecal coliform bacteria and rate of flow of “other direct sources” described in B.2.2.2.5

Fecal coliform grab samples, collected monthly by TDEC at sampling stations in South Fork Forked Deer River, Johnson Creek, and North Fork of the South Fork Forked Deer River were used for comparison with the simulated daily model results. Additional samples were collected at STORET Stations 002472 at Ozier Road (see Table B-1) and 002487 at Roberts Station Road (see Table 3) from 1985 to 1997; however, only from the data at Station 002472 is it possible to identify seasonal trends. The portion of the SFFDR watershed modeled for each water quality calibration represented the drainage area upstream of the monitoring station.

A comparison of simulated and observed daily fecal coliform concentrations at sampling stations in the listed streams are shown in Figures B-5 to B-12. Results show that the model adequately simulates peaks in fecal coliform bacteria in response to rainfall events. Often a high observed value is not simulated in the model due to lack of rainfall at the meteorological station as compared to the rainfall occurring in the watershed, or is the result of an unknown source that is not included in the model.

The sensitivity of the model to animal access to streams at select locations in the watershed is shown in Figure B-13. The model simulates reduced fecal coliform concentrations when cattle are not allowed access to streams. However, even without this load, fecal coliform concentrations exceeded the geometric mean standard.

Table B-1 Monitoring Data for South Fork Forked Deer River at Ozier Road

Sample Date	SFFDR @ Ozier Rd. (Sta. 002472)
	[#/100 ml]
2/8/89	60
4/19/89	90
7/5/89	150
10/5/89	650
1/2/90	460
3/21/90	86
6/6/90	360
8/9/90	190
1/3/91	150
4/23/91	97
7/2/91	220
10/3/91	170
1/21/92	28
4/21/92	240
9/10/92	150
12/15/92	71
3/24/93	370
6/15/93	220
9/16/93	740
3/17/94	36
9/20/94	120
12/5/94	1,300
3/15/95	96
6/21/95	1,200
9/20/95	240
12/20/95	680
6/11/96	440
5/20/97	710
5/21/97	2,100
5/22/97	270
10/14/97	1,700
10/15/97	600
10/16/97	200

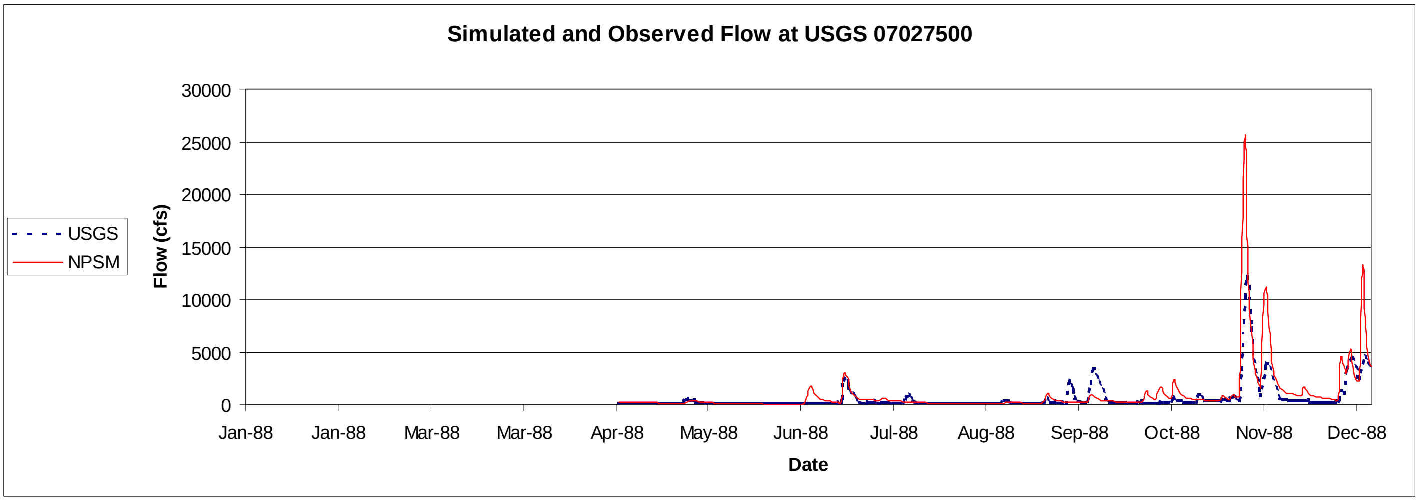


Figure B-1 Hydrology Calibration At USGS 07027500 (1988)

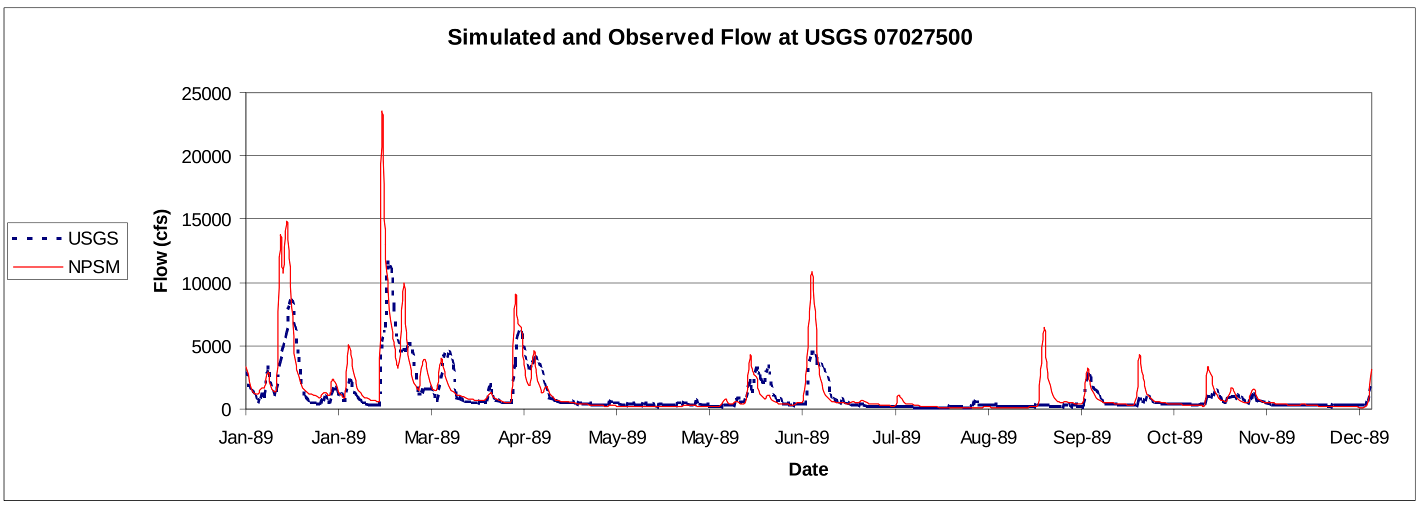


Figure B-2 Hydrology Calibration At USGS 07027500 (1989)

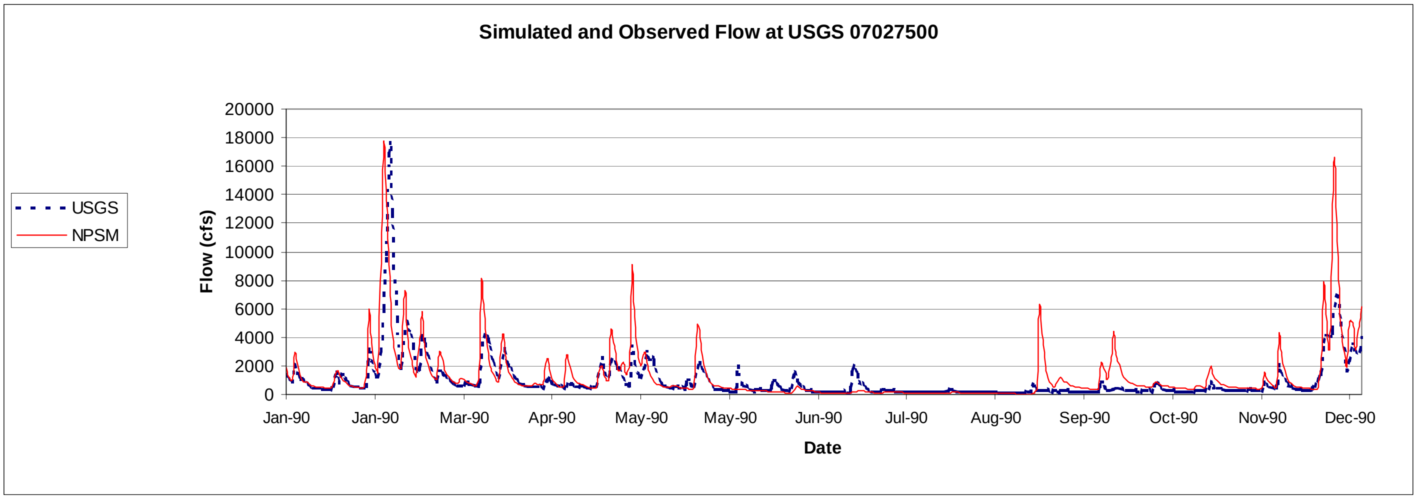


Figure B-3 Hydrology Calibration At USGS 07027500 (1990)

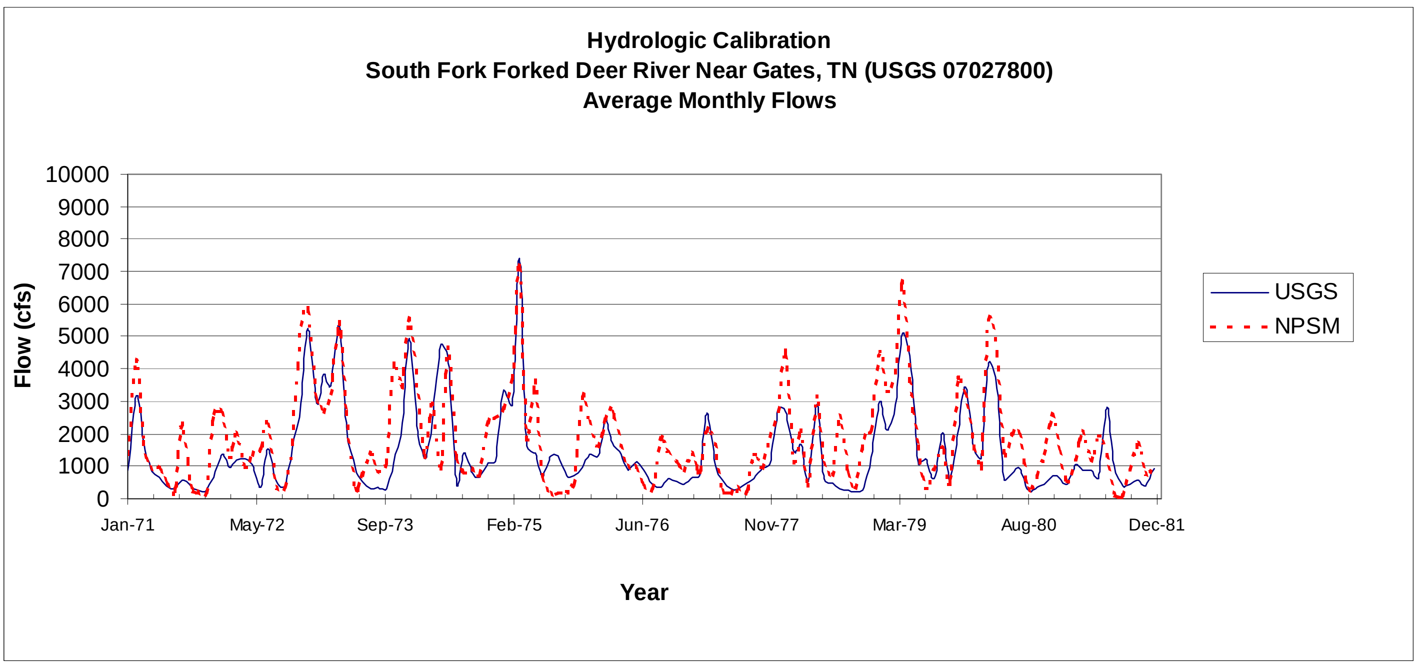


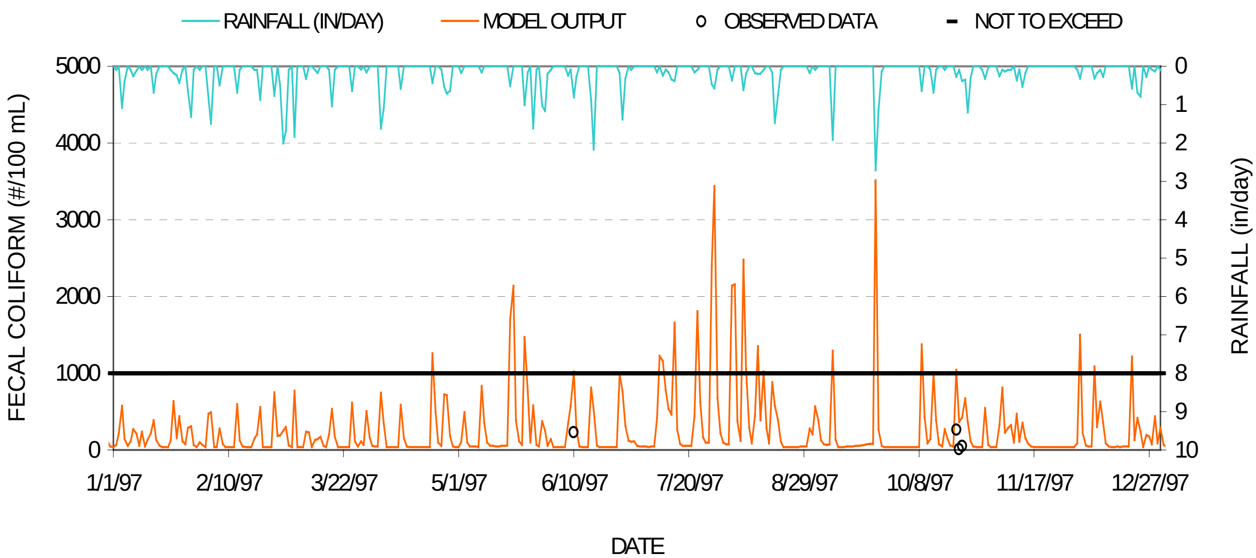
Figure B-4 Hydrology Calibration At USGS 07027800 (1971-1981)

MULTI-YEAR TIMESERIES MODEL VS DATA

STATION: **Johnson Creek**

MODEL RUN: 1

1 = EXISTING
2 = ALLOCATION 1
3 = ALLOCATION 2



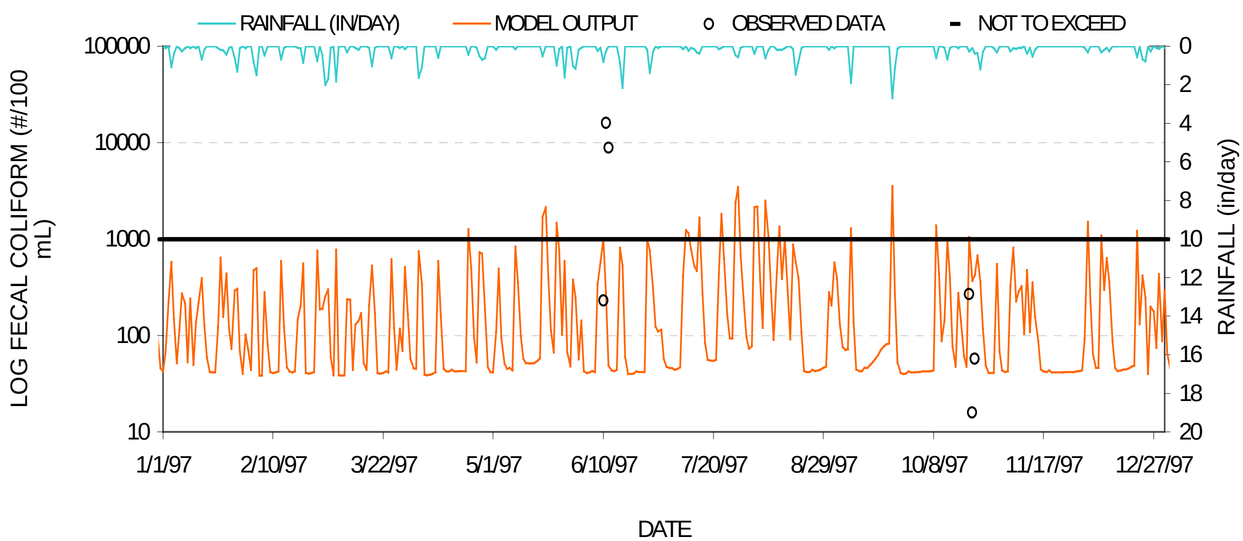


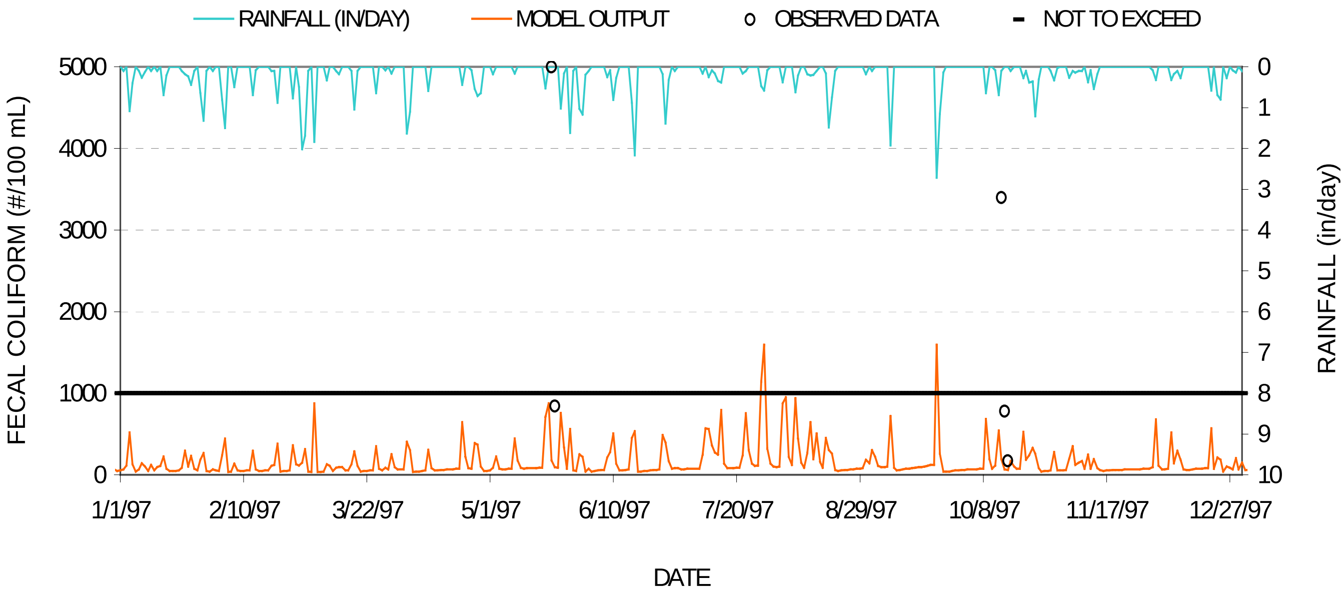
Figure B-5 Water Quality Calibration – Johnson Creek (1997)

MULTI-YEAR TIMESERIES MODEL VS DATA

STATION: **North Fork South Fork Forked Deer River**

MODEL RUN: **1**

1 = EXISTING
2 = ALLOCATION 1
3 = ALLOCATION 2



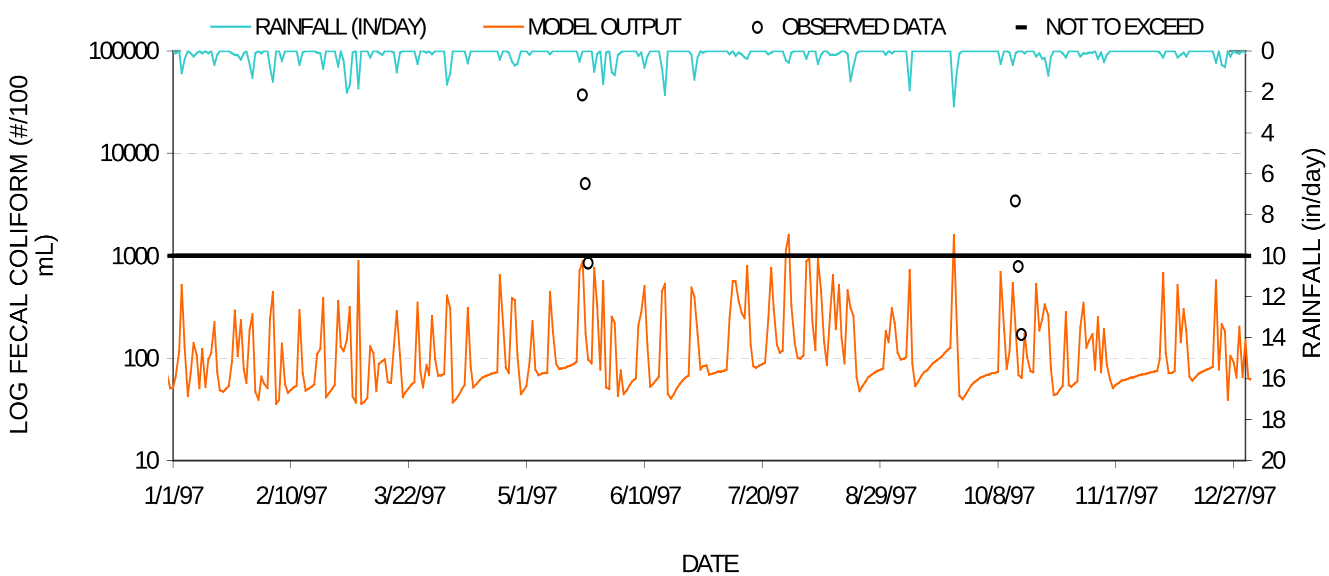


Figure B-6 Water Quality Calibration – North Fork of the SFFDR (1997)

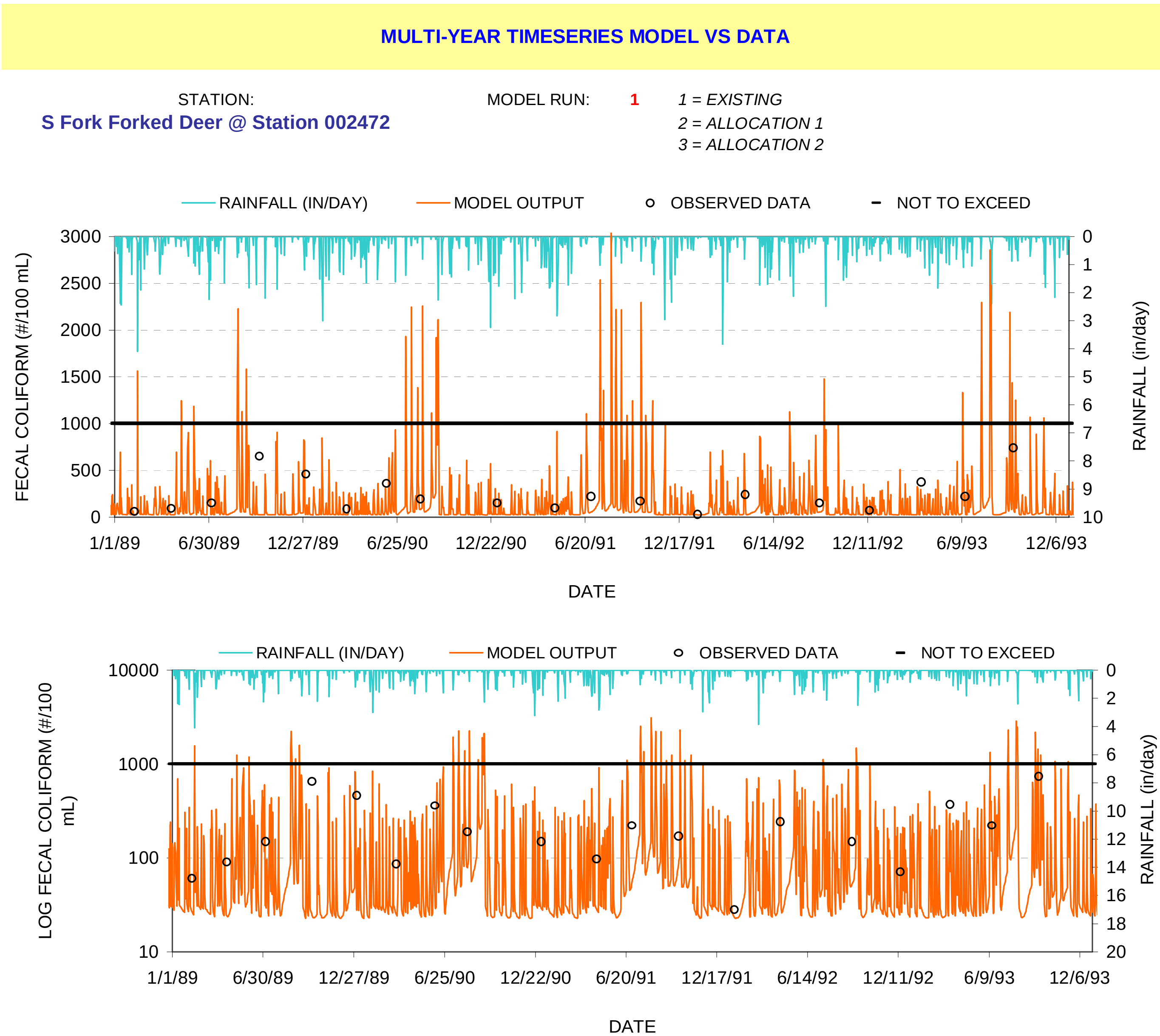


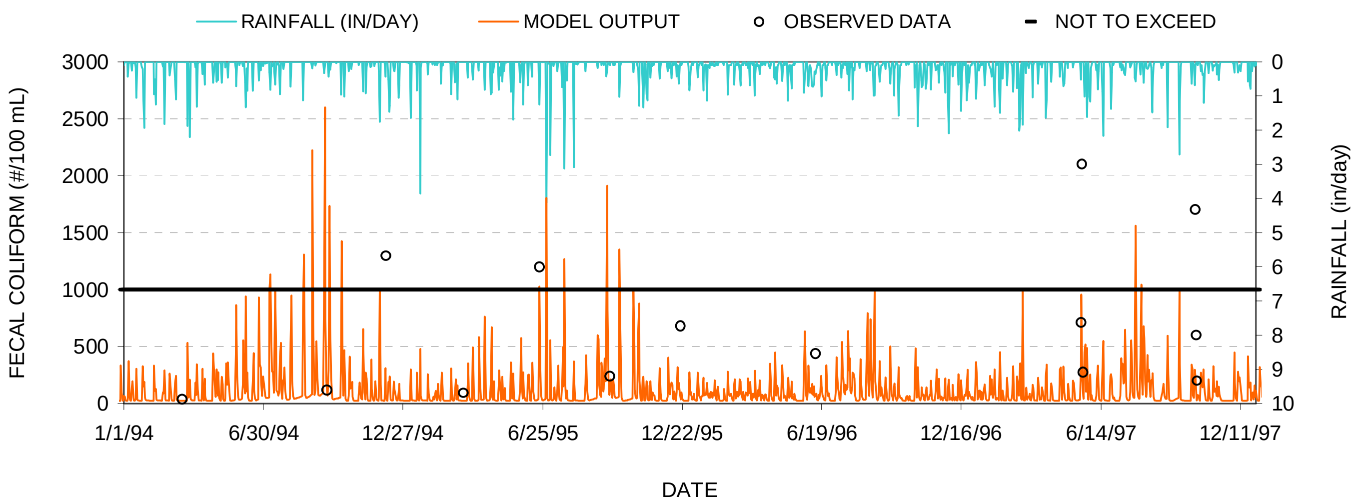
Figure B-7 Water Quality Calibration – SFFDR at Ozier Road (1989-1993)

MULTI-YEAR TIMESERIES MODEL VS DATA

STATION:
S Fork Forked Deer @ Station 002472

MODEL RUN: **1**

1 = EXISTING
2 = ALLOCATION 1
3 = ALLOCATION 2



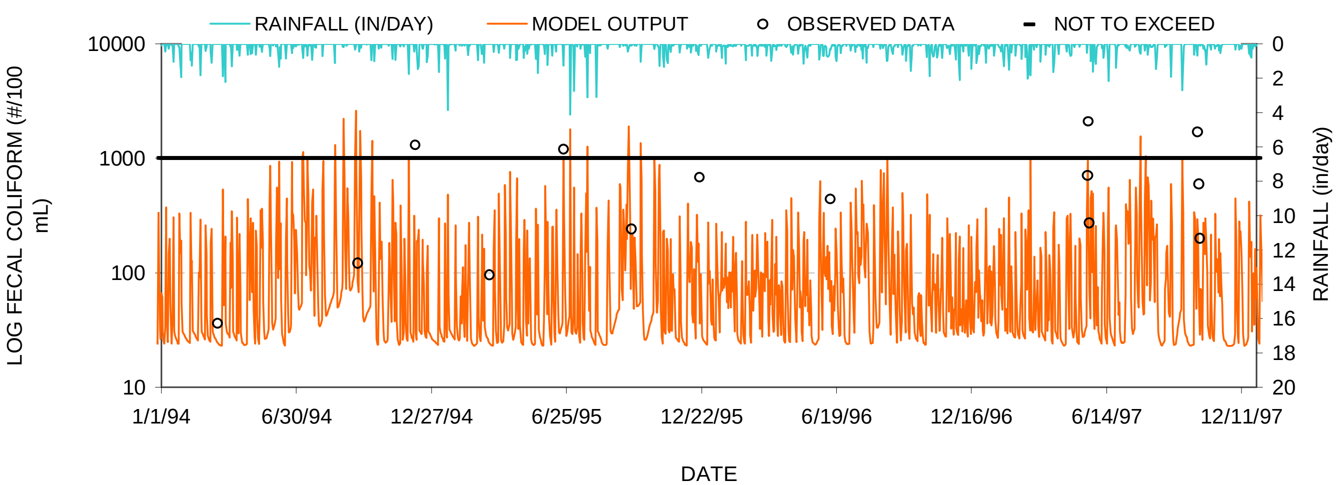


Figure B-8 Water Quality Calibration – SFFDR at Ozier Road (1994-1997)

MULTI-YEAR TIMESERIES MODEL VS DATA

STATION:
S Fork Forked Deer @ Station 002487

MODEL RUN: **1**

1 = EXISTING
2 = ALLOCATION 1
3 = ALLOCATION 2

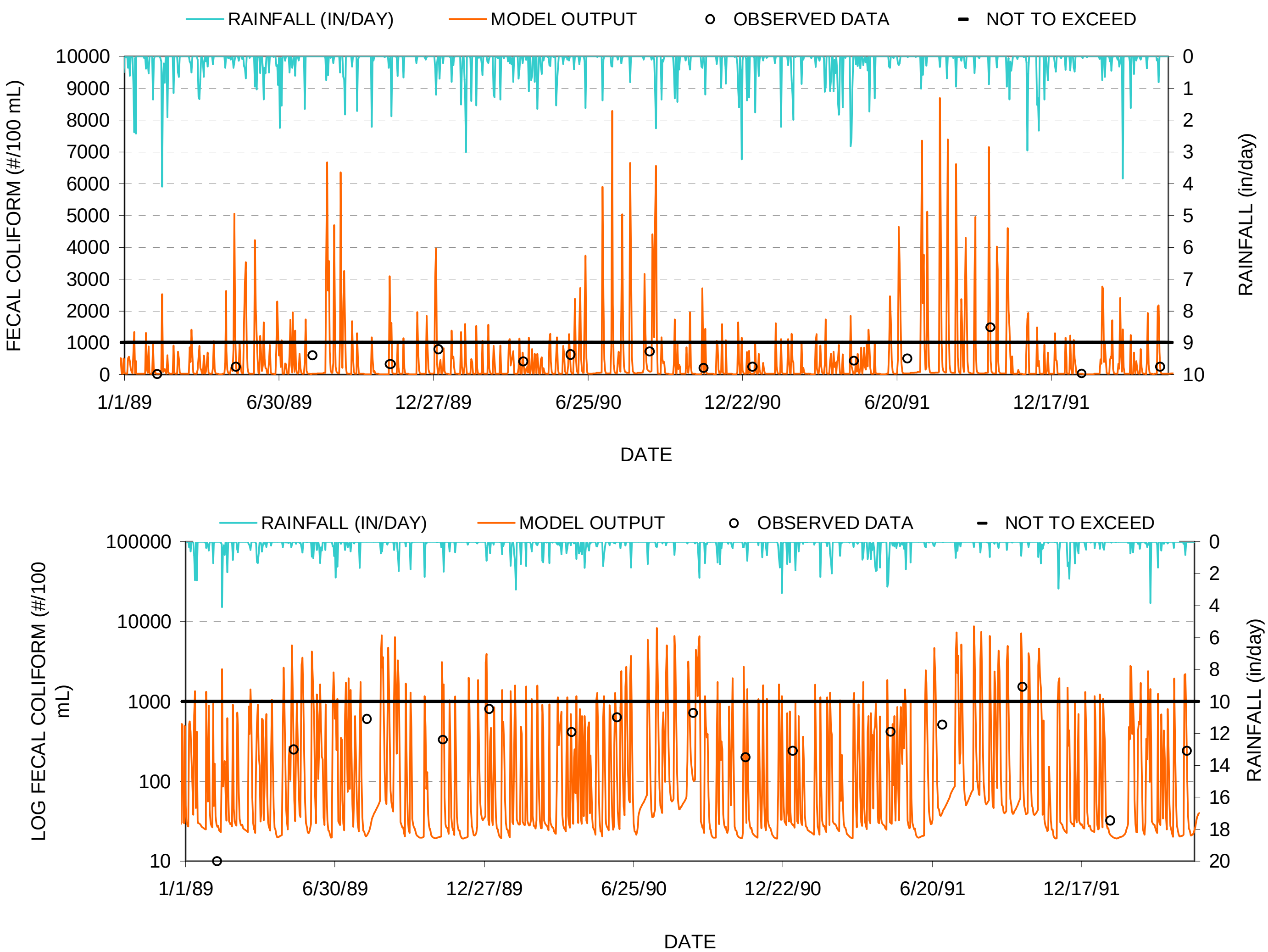
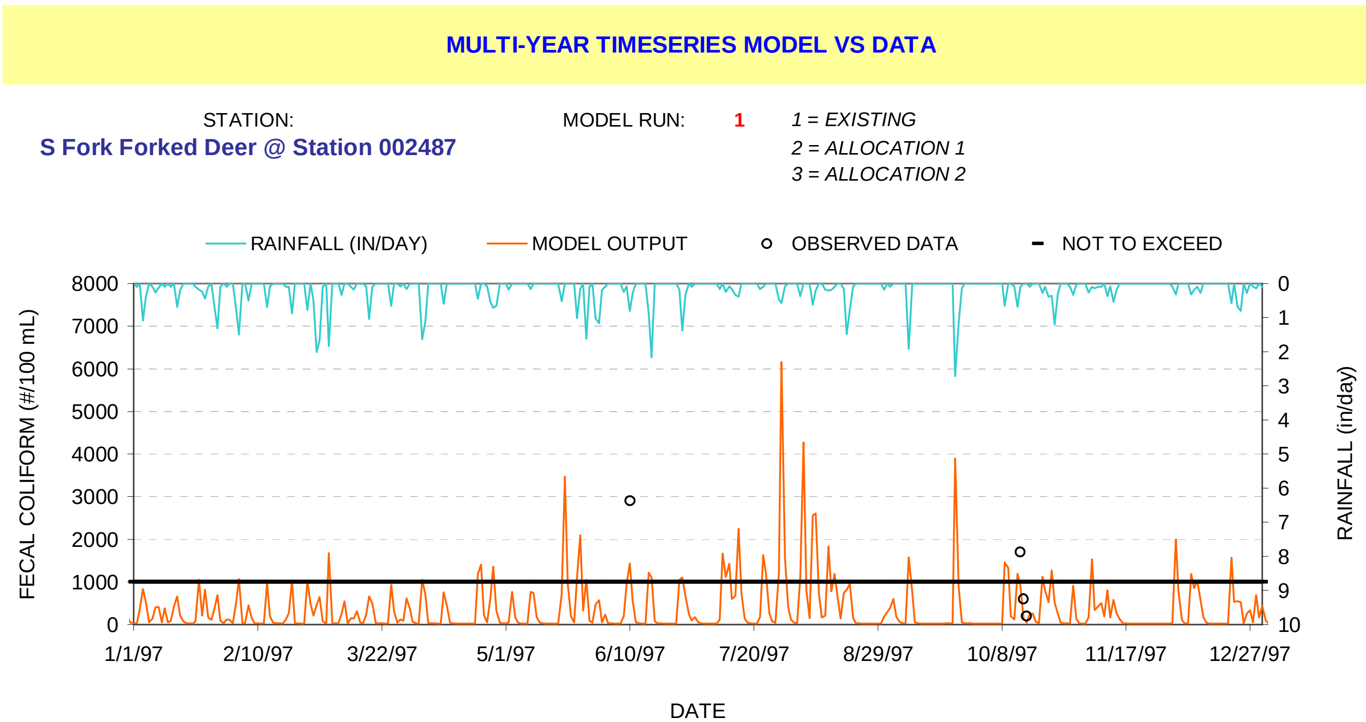


Figure B-9 Water Quality Calibration – SFFDR at Roberts Station Road (1989-1991)



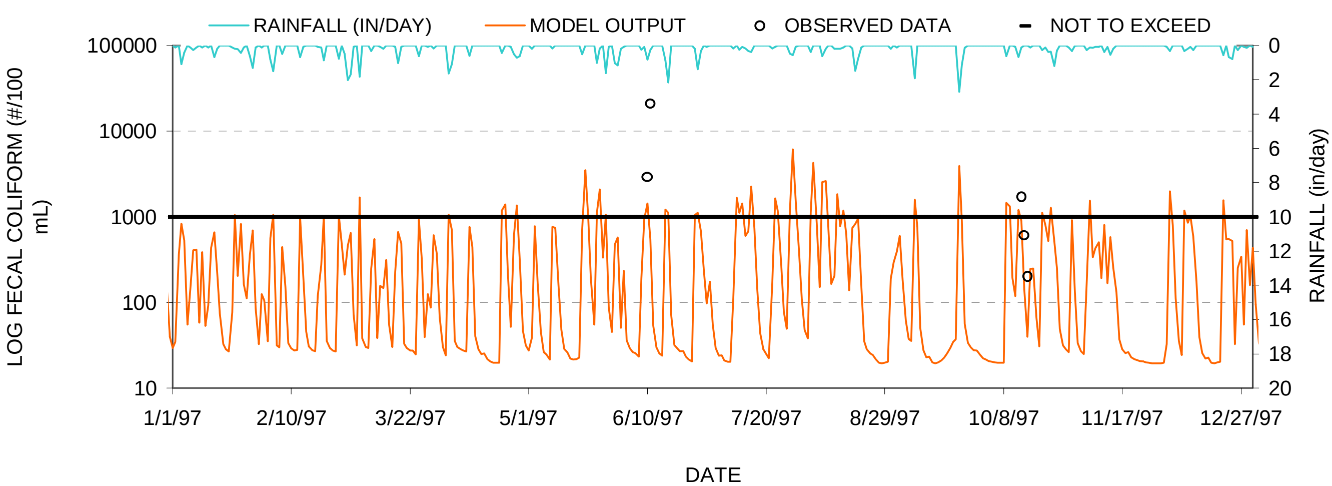


Figure B-10 Water Quality Calibration – SFFDR at Roberts Station Road (1997)

MULTI-YEAR TIMESERIES MODEL VS DATA

STATION: **S Fork Forked Deer @ Station 002500**

MODEL RUN: **1**

1 = EXISTING
2 = ALLOCATION 1
3 = ALLOCATION 2

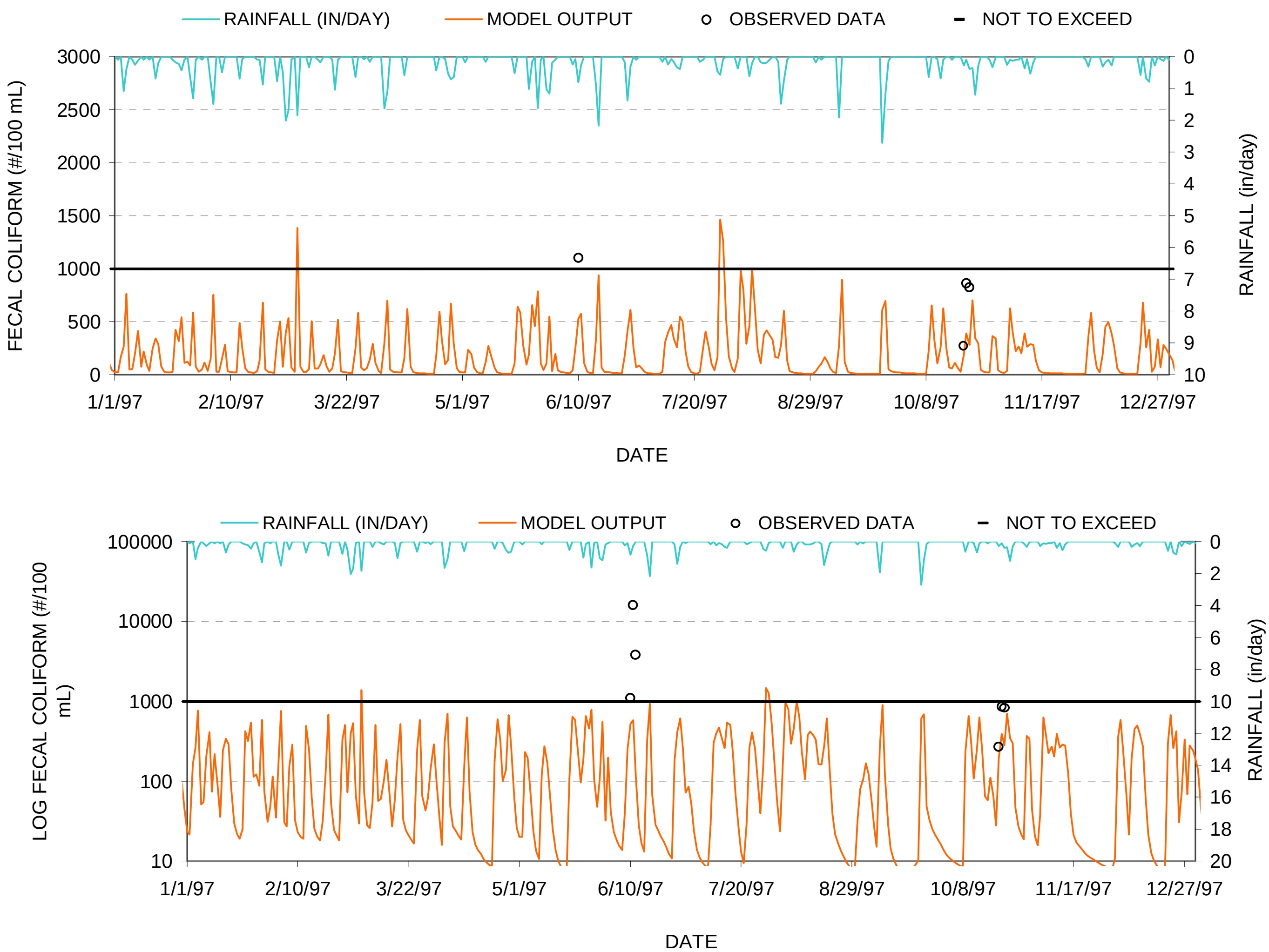


Figure B-11 Water Quality Calibration – SFFDR at Highway 54 (1997)

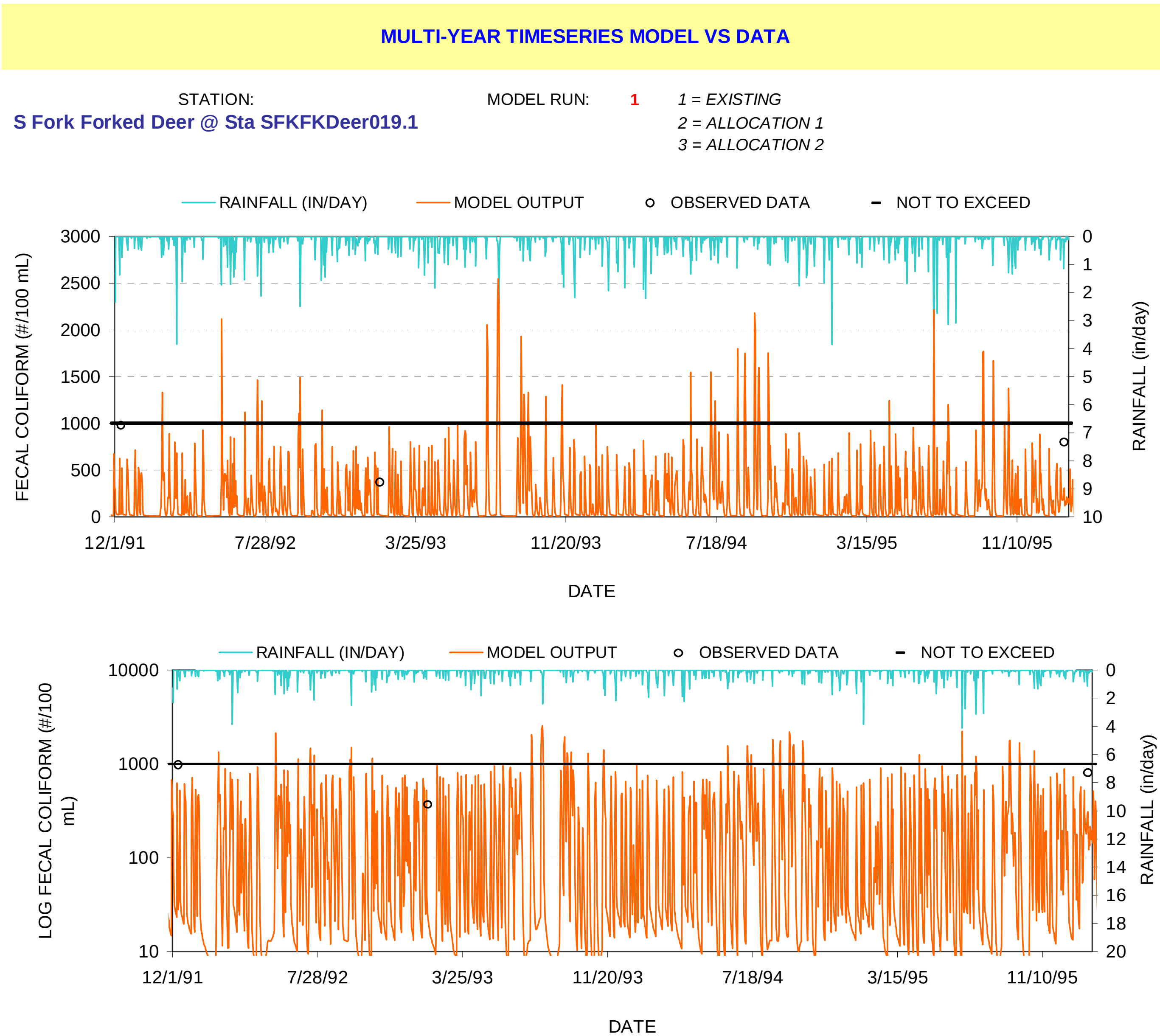
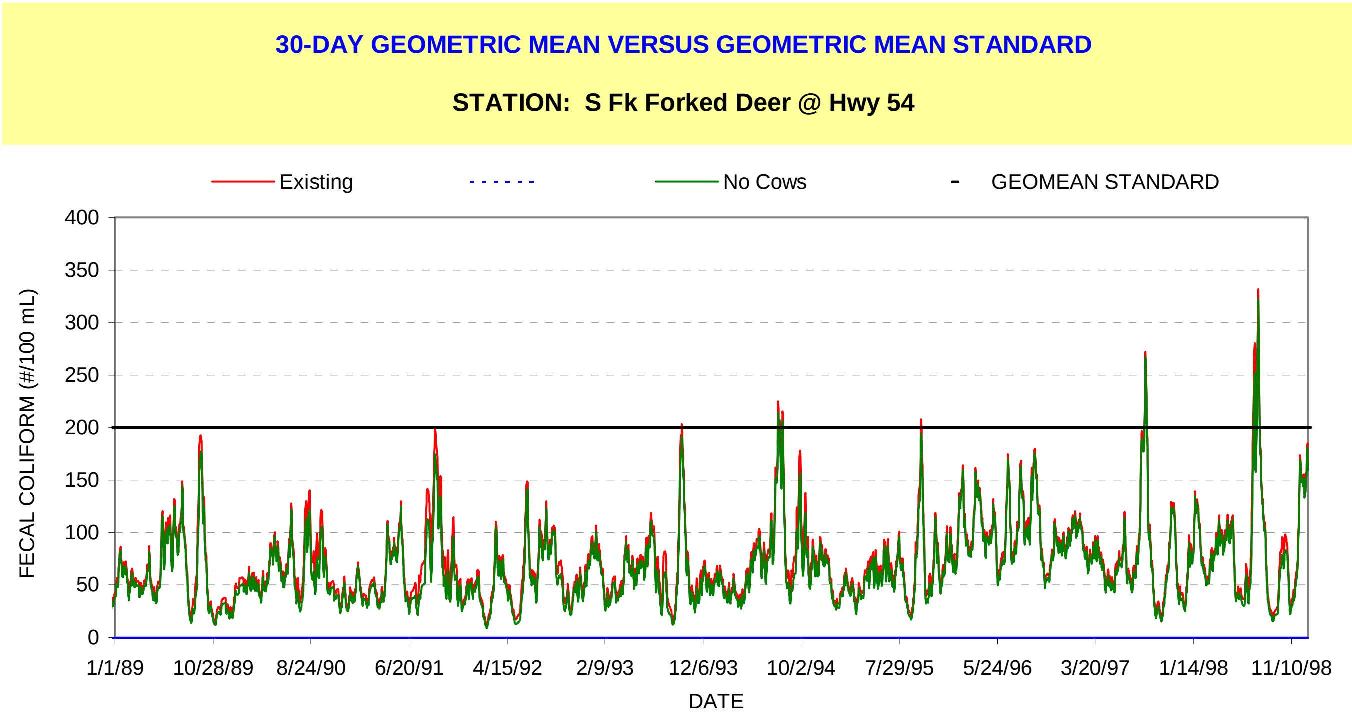


Figure B-12 Water Quality Calibration – SFFDR at Highway 88 (1991-1995)



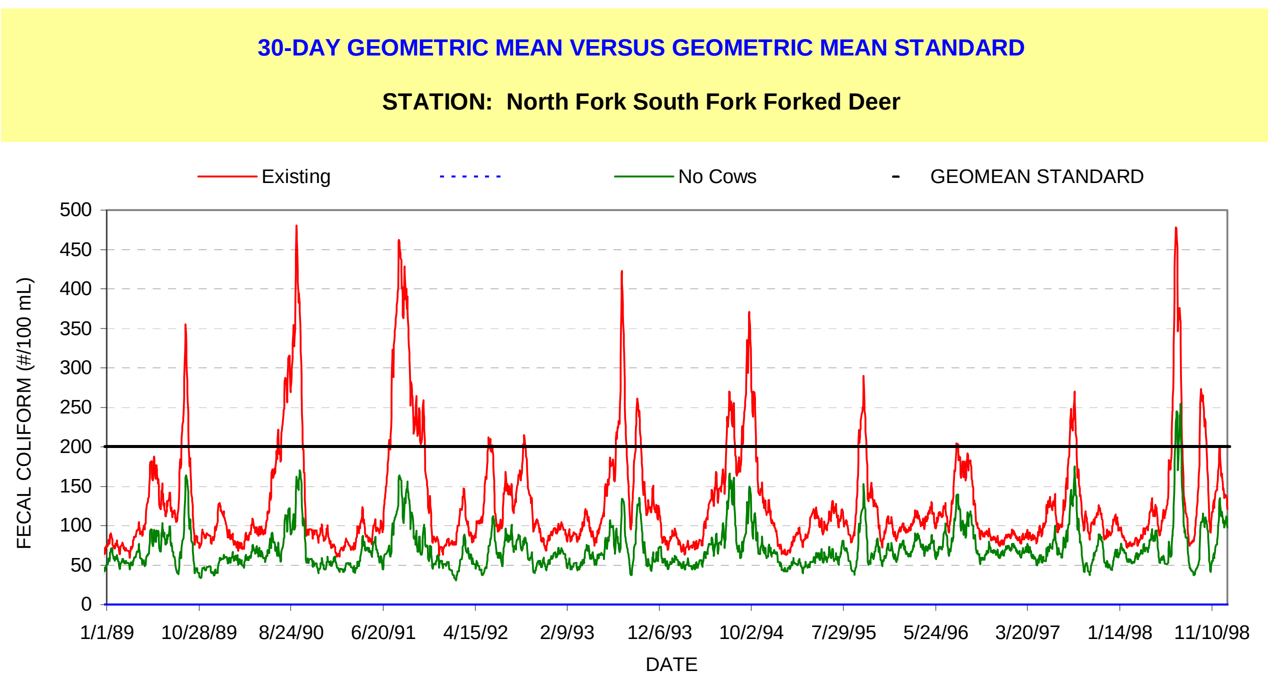


Figure B-13 Model Sensitivity to Animal Access In Streams at Select Stations In the SFFDR Watershed

APPENDIX C

Determination of Critical Conditions

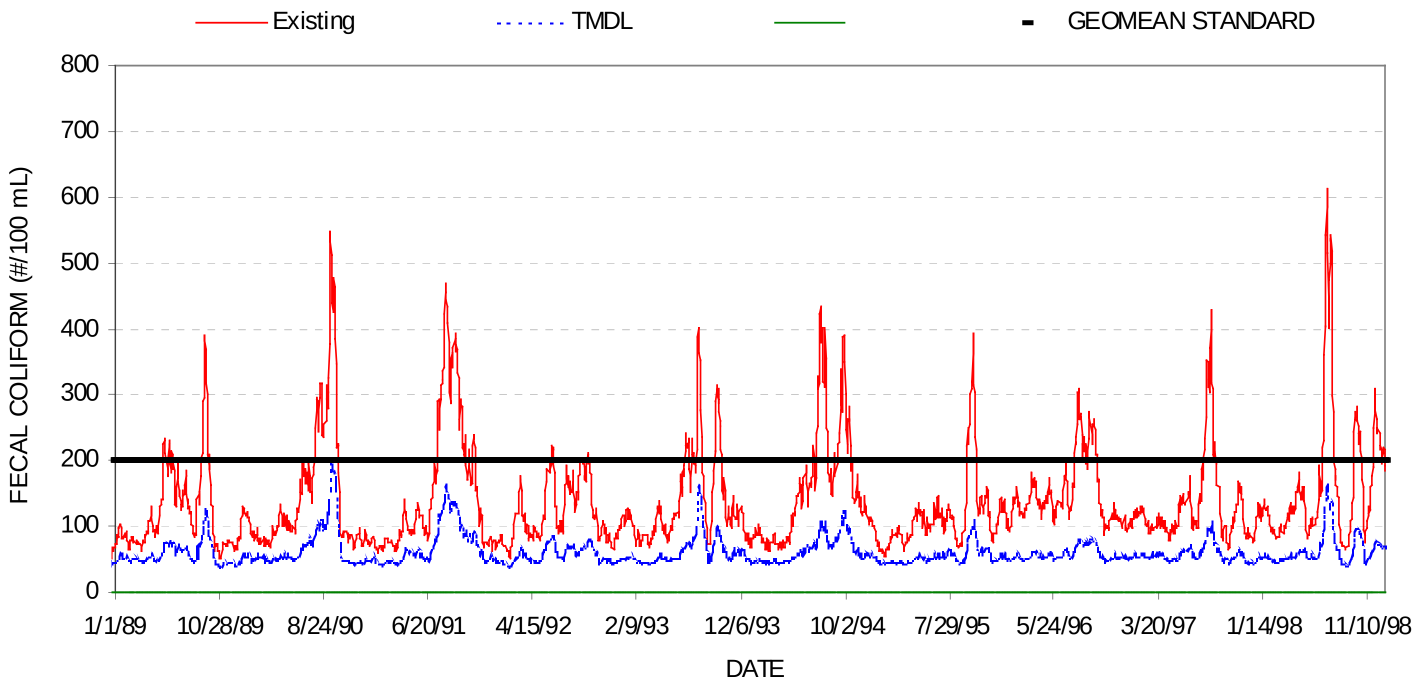


Figure C-1 Simulated 30-DayGeometric Mean for Johnson Creek

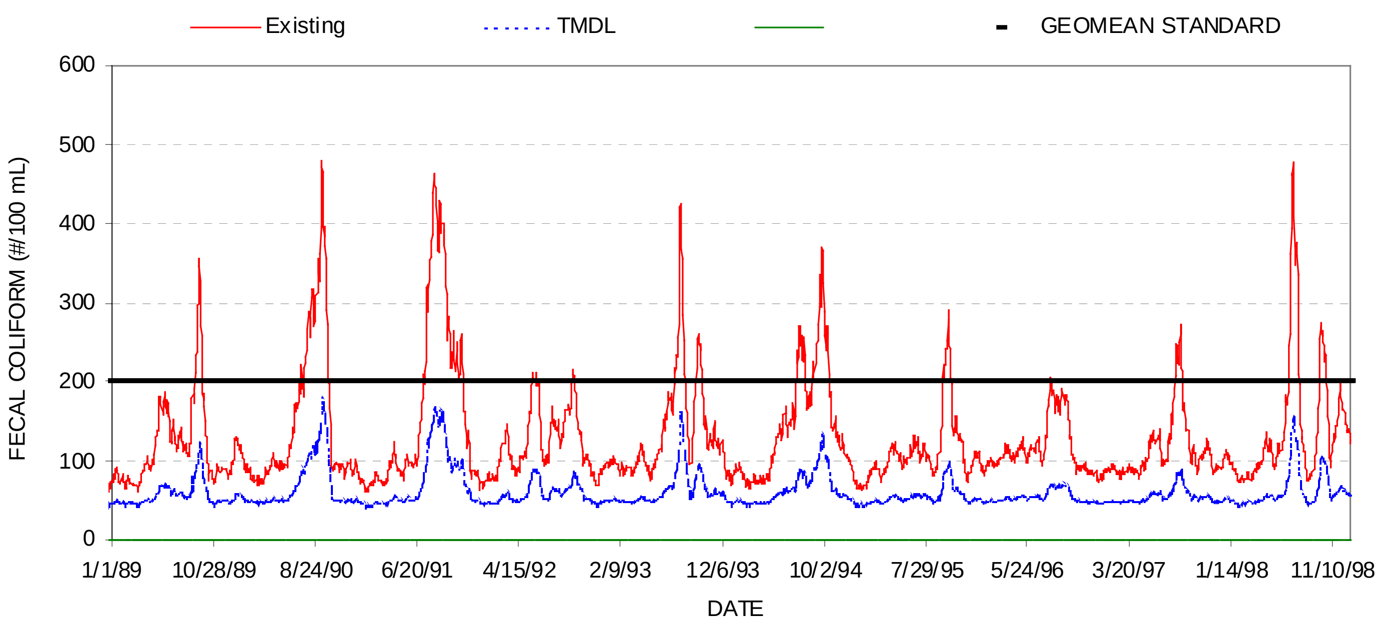


Figure C-2 Simulated 30-Day Geometric Mean for North Fork of the South Fork Forked Deer River

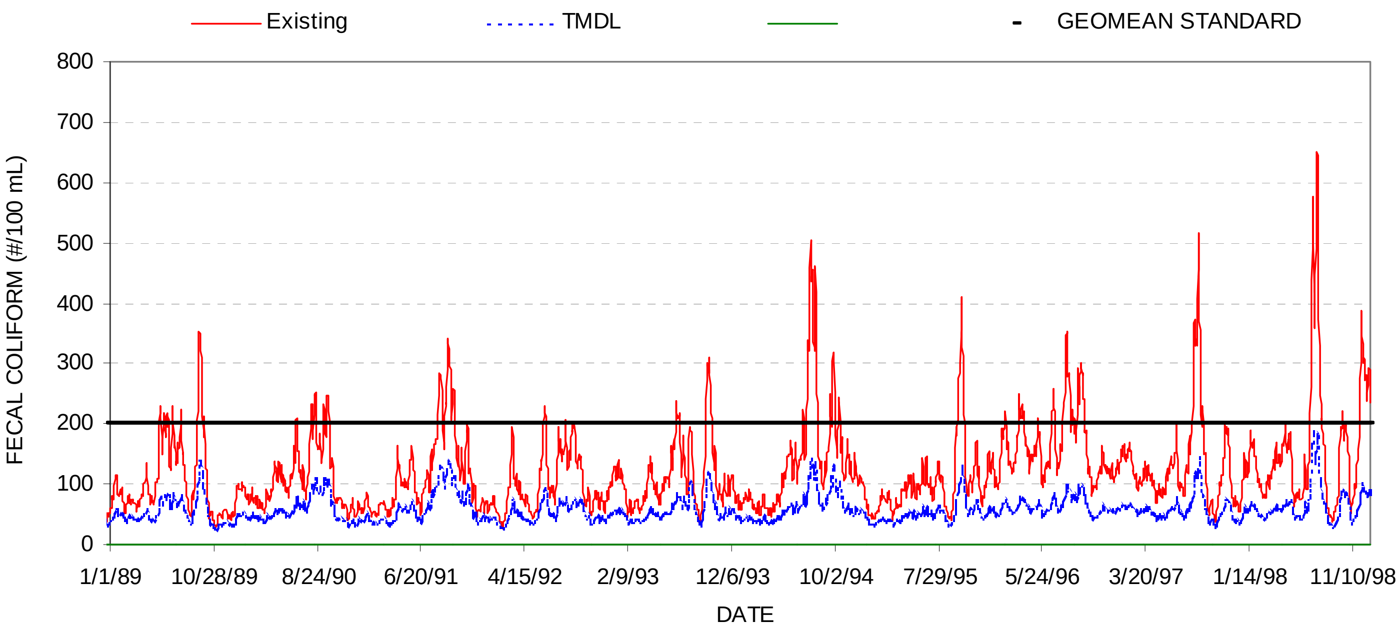


Figure C-3 Simulated 30-Day Geometric Mean in South Fork Forked Deer River at Roberts Station Road (Station 002487)

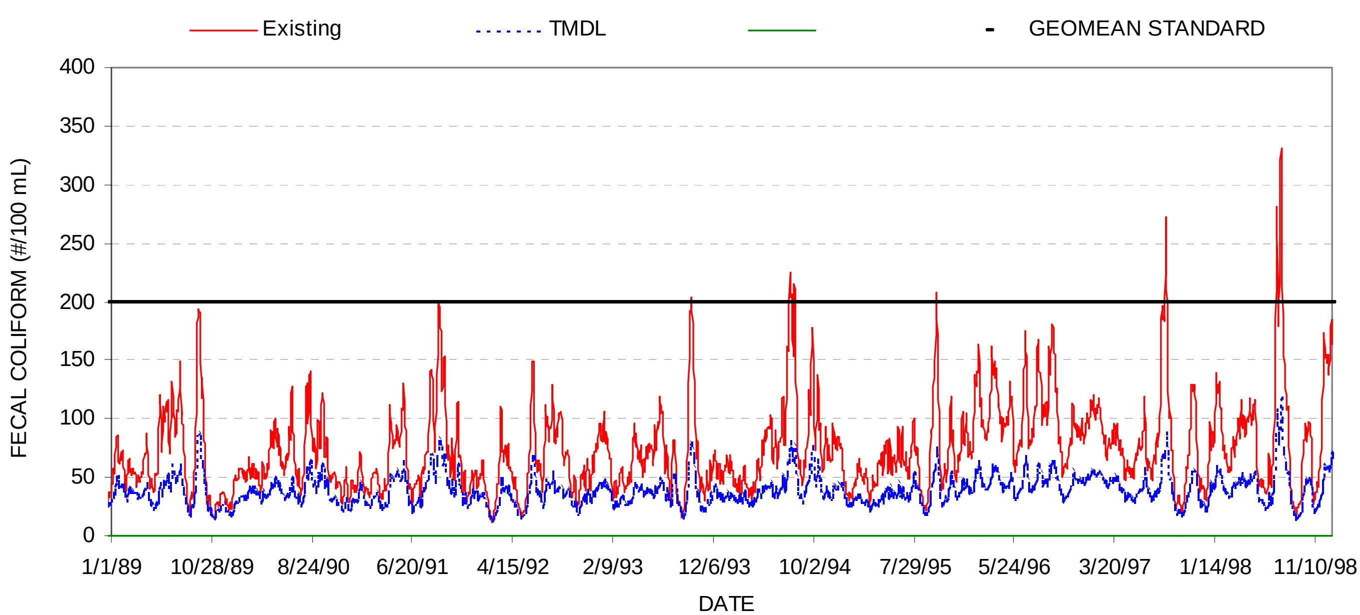


Figure C-4 Simulated 30-Day Geometric Mean in South Fork Forked Deer River at Highway 54 (Station 002500)

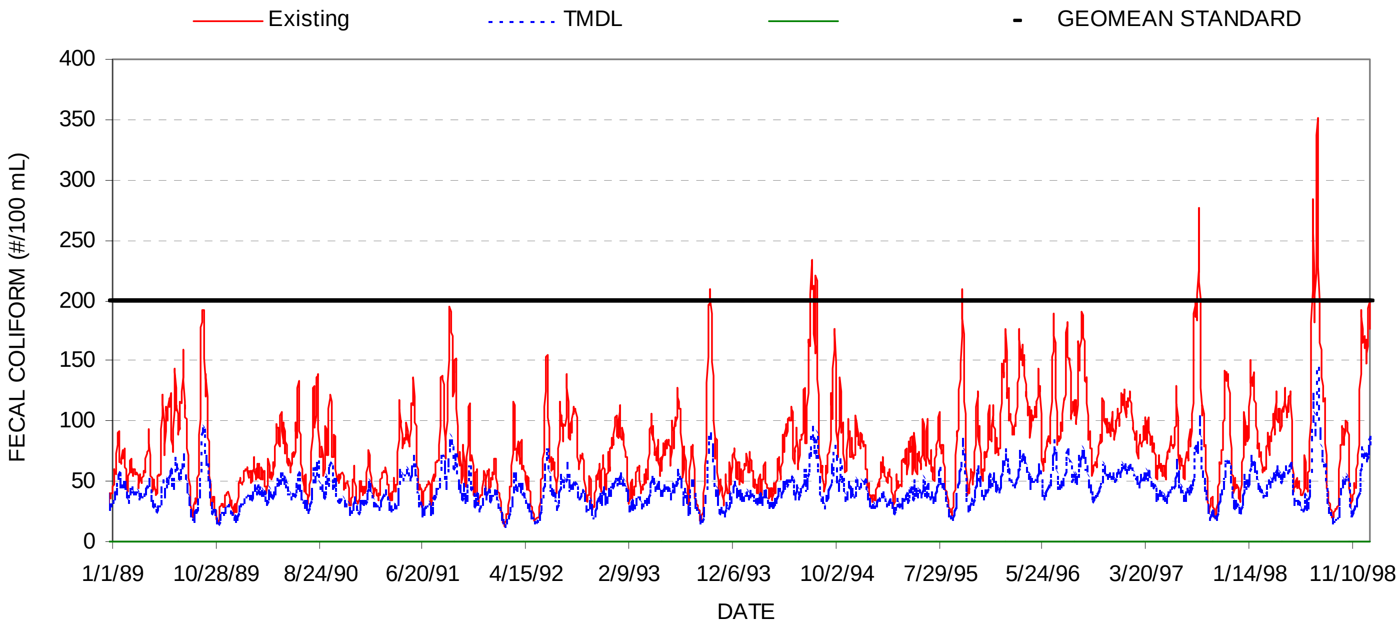


Figure C-5 Simulated 30-Day Geometric Mean in South Fork Forked Deer R. at Highway 88 (Station SFKFKDEER019.1)

APPENDIX D

Public Notice Announcement

STATE OF TENNESSEE
DEPARTMENT OF ENVIRONMENT AND CONSERVATION
DIVISION OF WATER POLLUTION CONTROL

PUBLIC NOTICE OF AVAILABILITY OF PROPOSED TOTAL MAXIMUM DAILY LOAD (TMDL) FOR FECAL COLIFORM IN SOUTH FORK FORKED DEER RIVER (Sumrow Cr. to Nixon Cr.) SOUTH FORK FORKED DEER RIVER (Nixon Cr. to Mud Cr.) SOUTH FORK FORKED DEER RIVER (Mud Cr. to Meridian Cr.) JOHNSON CREEK NORTH FORK OF THE SOUTH FORK FORKED DEER RIVER SOUTH FORK FORKED DEER RIVER WATERSHED (HUC 08010205), TENNESSEE

Announcement is hereby given of the availability of Tennessee's proposed Total Maximum Daily Loads (TMDLs) for fecal coliform in South Fork Forked Deer River watershed located in western Tennessee. Section 303(d) of the Clean Water Act requires states to develop TMDLs for waters on their impaired waters list. TMDLs must determine the allowable pollutant load that the water can assimilate, allocate that load among the various point and nonpoint sources, include a margin of safety, and address seasonality.

North Fork of the South Fork Forked Deer River, Johnson Creek, and three segments of the South Fork Forked Deer River (Sumrow Cr. to Nixon Cr., Nixon Cr. to Mud Cr., and Mud Cr. to Meridian Cr.) are listed on Tennessee's final 1998 303(d) list as not supporting designated use classifications due, in part, to pathogens associated with urban storm water runoff and agriculture. The TMDLs utilize Tennessee's general water quality criteria, USGS continuous record station flow data, in-stream water quality monitoring data, a calibrated dynamic water quality model, and an appropriate Margin of Safety (MOS) to establish allowable loadings of fecal coliform which will result in reduced in-stream concentrations and the attainment of water quality standards. The TMDLs require reductions in fecal coliform loading of approximately 72% to 84% in the five listed waterbodies.

The proposed fecal coliform TMDLs may be downloaded from the Department of Environment and Conservation website:

http://www.state.tn.us/environment/wpc/tmdl.htm

Technical questions regarding this TMDL should be directed to the following members of the Division of Water Pollution Control staff:

Bruce R. Evans, P.E., Watershed Management Section
Telephone: 615-532-0668

Sherry H. Wang, Ph.D., Watershed Management Section
Telephone: 615-532-0656

Persons wishing to comment on the TMDLs are invited to submit their comments in writing no later than April 30, 2001 to:

Division of Water Pollution Control
Watershed Management Section
6th Floor, L & C Annex
401 Church Street
Nashville, TN 37243-1534

All comments received prior to that date will be considered when revising the TMDL for final submittal to the U.S. Environmental Protection Agency.

The TMDL and supporting information are on file at the Division of Water Pollution Control, 6th Floor, L & C Annex, 401 Church Street, Nashville, Tennessee. They may be inspected during normal office hours. Copies of the information on file are available on request.

Note: The announcement states that the TMDLs require reductions in fecal coliform <u>*loading*</u> *of approximately 72% to 84% in the five listed waterbodies. This reflects the proposed TMDLs that were placed on Public Notice. The final TMDLs, however, require reductions in* <u>*in-stream*</u> *fecal coliform concentrations of approximately 34% to 74% in the five listed waterbodies.*

APPENDIX E

Public Comments Received

From: Barry Sulkin <sulkin@bellsouth.net>
To: <swang@mail.state.tn.us>
Date: 4/9/01 12:07PM
Subject: Forked Deer BacT TMDL Comments

April 9, 2001

Sherry Wang
Division of Water Pollution Control
Nashville, TN

Via Email to: swang@mail.state.tn.us

Re: South Fork Forked Deer River
Draft TMDL for Fecal Coliform
Dated Feb. 2, 2001
Public Comments

Dear Sherry:

I am writing to submit comments on this proposed TMDL on behalf of the Tennessee Environmental Council and the Tennessee Clean Water Network. While it is recognized that a significant amount of impressive work has gone into this effort, there are a number of issues that are not clear or need to be resolved. Some of the same issues were raised in comments submitted on previous TMDLs, but to date we have received no responses. There may be some reasonable explanations that can resolve some of the issues, while others may be legitimate differences of positions. However the lack of any response to our comments and questions, or opportunity for meaningful early involvement in developing TMDLs makes the much touted public participation or stakeholder process appear meaningless and insincere, and not in keeping with EPA guidance. Knowing the personal commitments of you and some of your colleagues, we are somewhat baffled by the apparent indifference to this problem.

It seems pointless to repeat some of our previous comments that are at issue again in this latest TMDL and still need to be addressed. As often described, a fundamental component of making a program like TMDL work is meaningful public involvement and support. As far as we can tell, in this and other similar TMDLs the only public participation opportunity offered by WPC is a mere 30-day comment period after the draft TMDL is already done. With the current interest of our organizations and some limited funding, we have been trying to participate in this program. However, with little to show for our efforts beyond getting the program started, it is uncertain how long we will continue in this manner, especially with diminishing funds and public interest for a program where we appear ignored. We had thought it was our mutual intent that after the TMDL program was finally initiated we could work with WPC to establish principles, protocols, and procedures for this program, and we could work with you to make public participation meaningful by coordinating and working with local and environmental groups and develop some TMDLs, not just comment at the end. It was not presumed that all issues would be resolved, but that at least there could be an ongoing dialogue and process to be involved and work on issues as they arose. Unfortunately this has not been the case, and thus far what we have seen of the Tennessee TMDL program has been one-sided, with the effected public interest we represent being essentially left out. We know it can be done better and hope you agree.

It is hoped that your division will take these comments to heart and examine the process. We ask again that a response to comments be provided, and a dialogue be initiated to work on some of the issues of concern, and to allow participation earlier in the process. Without some such changes, it is doubtful that any public interest can be sustained. It is our understanding that federal regulations governing the TMDL program found in 40 CFR Part 130, require each state to have a public participation procedure, and maintain a Continuing Planning Process (CPP) where the process is established. We are unaware if Tennessee has met this requirement, but if so, please provide us with a copy of the procedures for public participation in the TMDL program. If such does not exist, we are willing to work with you to develop such and fulfill this requirement, and hopefully instill support from our constituents.

Since our last submission of comments on a similar proposed TMDL for Fecal Coliform, EPA has released a national guidance document called “Protocol for Developing Pathogen TMDLs” (EPA 841-R-00-002, January 2001) and we have had a chance to review it and compare it to what is being done in Tennessee. While this guidance is not regulation and does not resolve all issues, it does describe required components and serve as means to help review the adequacy of the related Tennessee TMDLs. A comparison shows that some things are in keeping with the EPA guidance, while others are off the mark.

Regarding public input, the EPA Protocol discusses public input requirements, and states that “...stakeholders... should be involved in the development process as well... Stakeholders should be made aware of and engaged in the decisions regarding... the modeling results or data analyses used to establish TMDLs for the waterbody and the pollutant control strategies...” (Page 7-4). The EPA Protocol also states that the CPP is required by section 303(e) of the Clean Water Act, and that it must contain a description of the public process (Page 9-3). This draft TMDL, like previous ones, does not include a section on public participation, and in fact does not even make mention of it in the document. Thus even if there were no other issues, we find that this is not a complete TMDL under the EPA rules.

The EPA Protocol states that since 1986, EPA has encouraged states to use E. coli or other bacteria instead of fecal coliform (Page 4-5). Although Tennessee has criteria for E. coli, this TMDL makes no mention of this. While there may be pros and cons to using this newer pathogen indicator instead of or along with fecal coliform, it is at least worthy of discussion. The EPA Protocol also discusses the use of standards with multiple parts, such as Tennessee’s where there is both a geometric mean and a “not to exceed” or maximum. It says that the availability of data dictates which should be used, and where “...there may not be enough historical data to support the use of the geometric mean criteria as the target... the ‘not to exceed’ value may be used.” (Page 4-6). On previous similar draft TMDLs we have comment (without response) on the lack of consideration and protection of the maximum criterion, and the use of the mean where there are inadequate data. We believe that TMDLs must address all applicable criteria for the pollutants of concern, and must include the Maximum criterion if there is one, and the acceptable Maximum Daily Load as in the name.

This draft TMDL states on page 6 that “...insufficient data were collected to calculate 30-day geometric mean values...”, however it goes on to use the mean anyway for the target and modeling. This is not logical or in keeping with the exact issue in the EPA Protocol discussed above. Further it is noted that the modeling outputs given in the appendix show a poor match between observed and modeled or predicted fecal levels. This shows great uncertainty and would appear to obviously be due at least in part to the model using a geometric mean, and the observed data being individual (or maximum) values. Thus the confidence of the modeling cannot be directly assessed. This also points out the need for a real, explicit, and significant margin of safety (MOS), and an adjustment to the monitoring program so that there is consistency. As pointed out in previous comments, meeting the mean does not assure meeting the maximum. While there may again be pros and cons to use of the mean and maximum criteria, they both need to be addressed, and it is certainly worthy of discussion.

This TMDL is stated as being a "phased approach", with loading decisions to be potentially upgraded with additional monitoring and model refinement, and the hope that future, but somewhat vague efforts, such as a municipal storm water program will help solve the problems. EPA guidance describes the concept of phased TMDLs as those where there is the need for additional and more accurate information, with initial allocations made using what information is available with a large MOS that can be reduced if appropriate as more accurate estimates are justified in later phases. In the case of this TMDL, although it is admitted that there is a lack of adequate data and it is described as a phased TMDL, the only MOS is the usual claim of implicit conservative assumptions. Throughout this TMDL there are numerous descriptions of the use of estimates, various uncertainties, and the lack of adequate data. In this case, what will be done for the planned future phases - use less conservative assumptions? In reviewing this and previous proposed TMDLs we find the same claim made regardless of level of accuracy, assurance, or information available, and with the usual assumptions used. This is not logical or in keeping with the concept of the phased approach as given by EPA.

As stated in the EPA Protocol (Page 7-3), "By definition, TMDLs involve WLAs that are more stringent than technology-based limits...". This proposed TMDL only calls for the standard technology-based fecal coliform mean limit of 200 for all point sources, with no mention of the Daily Maximum limit or load reductions. The EPA Protocol discusses how TMDL allocations need to be translated into permit requirements (page 7-2), and this is explained in even greater detail in EPA references primarily addressing other parameters, but based on the same concepts (see Technical Support Document for Water Quality-based Toxics Control - EPA/505/2-90-001). In the case of this and other proposed TMDLs, as well as typical Tennessee water quality-based permits, "allocations" are simply put directly into permits as average limits without translations that account for factors such as maximum criteria, effluent variability, or sampling frequency. This issue needs to be discussed in terms of this proposed TMDL, as well as for the permit program in general.

The EPA Protocol and the referenced 1991 guidance document for TMDLs - EPA 440/4-91-001 states that a phased TMDL must contain a monitoring plan, assurances that nonpoint source control measures will achieve the expected load reductions (Page B-5), and an adaptive management plan for adjusting controls and the TMDL (Page 8-4). This draft TMDL is lacking in these aspects. In addition to a limited mention of future monitoring plans, it proposed to permit all existing and any additional dischargers, regardless of volume, to discharge bacteria right up to the mean criterion level into already overloaded waters. It also delays implementation of any new municipal storm water programs for 2 years (and proposes no limits for such), and thus in difference to often heard EPA guidance, it proposes no reductions in point source loads to off-set or drive reductions in nonpoint sources. In effect, as written there is no reasonable assurance that this TMDL as proposed will do anything to improve the waters in question.

There are a number of other issued worthy of comment that were noted in reviewing this proposed TMDL. However, due to limitation of our time and resources, and the lack of assurance that our comments will result in productive discussions or even a response, further comments will not be made at this point. We hope that the state and EPA will see the need to adjust the TMDL program in Tennessee to make the process more meaningful so as to reward and encourage public involvement. Otherwise, we fear that it will just be a paper program that consumes a lot of time and resources for all involved, with little to show in terms of cleaner water and public support.

Respectfully,

Barry Sulkin

cc: EPA, Region 4

APPENDIX F

Response to Public Comments

The only written comments received on the South Fork Forked Deer River (SFFDR) fecal coliform TMDL were submitted by Barry Sulkin on behalf of the Tennessee Environmental Council and the Tennessee Clean Water Network (see Appendix E). These comments appear to address six primary topics. The Division of Water Pollution Control's (DWPC's) response in each of these topical areas is given below:

1. Public Participation Process

TMDLs in Tennessee are developed within the context of the State's Watershed Management Approach. The Watershed Approach is based on the concept that Tennessee's waters are best assessed and water quality problems best addressed at the watershed level. This approach, which considers both point and non-point contributions to the watershed, emphasizes cooperation with local, state, and federal agencies and encourages public participation in the process. Watersheds in the State, corresponding to USGS eight digit hydrologic unit codes (HUC), have been divided into five groups. The Division's activities in each group are sequenced into a five year cycle and include:

Planning & Data Collection
Monitoring
Assessment
WLA/TMDL Development
NPDES Permit Issuance
Watershed Management Plan Development

Detailed information regarding the Watershed Management Approach can be found on the TDEC website at http://www.state.tn.us/environment/wpc/wshed1.htm.

Widely advertised public meetings are held at least twice during the five year cycle (three times during the initial five year cycle) and additional watershed meetings held when requested by local stakeholder groups. These meetings provide the opportunity for early involvement in watershed planning, monitoring, assessment, and TMDL development activities by interested local parties. The most recent series of meetings were the Group 3 watershed assessment meetings held during Spring, 2001. Meetings were held in nine watersheds with an average attendance of approximately 25 people per meeting. Topics discussed included the watershed approach, watershed water quality plans, water quality monitoring and assessment, and WLAs/TMDLs. Approximately 60 watershed meetings have been held throughout the State thus far.

As with previous TMDLs, public participation activities are documented in the TMDL document prior to final submission to EPA for approval. These include, but are not limited to, a summary of website posting, legal notices in newspapers, direct mailings, meetings with stakeholders in the watershed, transcripts of written comments received, and DWPC responses to these comments. Approved TMDLs are posted on the TDEC website.

2. Dual Parameter Standard – Fecal Coliform & *E. coli*

Fecal coliform and *E. coli* bacteria are both indicator organisms for the presence of pathogens in water. Fecal Coliform was selected as the most suitable indicator for the SFFDR TMDLs due to the availability of historical monitoring data and literature values to support analysis. Fecal coliform/*E. coli* ratios are not generally available since they tend to be watershed specific.

Fecal coliform data represent the largest number of bacteria samples collected in the SFFDR watershed. The approach used in model development was to simulate the parameter represented by the largest data group in order to achieve the best calibration over a range of hydrologic events. Analysis using the Hydrological Simulation Program - FORTRAN (HSPF) model is limited by the availability of suitable meteorological data. At the time of model development, meteorological data was only available through December 31, 1998. Therefore, it was not possible to compare simulated and observed *E. coli* in the model. The State of Tennessee now routinely collects *E. coli* samples concurrently with fecal coliform and will consider both in future evaluations.

3. Dual Numerical Standard for Fecal Coliform

Most of the historical stream data available for the SFFDR watershed represent instantaneous fecal coliform concentrations. This data was used to perform model water quality calibrations. A ten year period that included a wide range of environmental and stream conditions was evaluated to determine the critical period for analysis corresponding to the highest violation of the 30 day geometric mean standard. Model results indicate that by calculating load reductions to meet the geometric mean standard the instantaneous standard arel also expected to be met.

4. Margin of Safety (MOS)

Based on comments received in a recent stakeholder meeting, the TMDL analysis was revised to include a 10% explicit margin of safety (MOS) in addition to the implicit MOS used in the original analysis. Conservative assumptions representing implicit MOS are specified in section 8.3 of the TMDL document.

5. Technology vs. Water Quality Limits for Fecal Coliform

Fecal coliform permit limits for point source facilities reflect the instream water quality criteria specified by *State of Tennessee Water Quality Standards, Chapter 1200-4-3 General Water Quality Criteria, October, 1999*, and are considered water quality based limits. In the vast majority of cases, permitted facilities in Tennessee have not been required to discharge at concentration levels below instream criteria. Since less than 1% of the existing fecal coliform load is due to point source discharges, the implementation recommendations in the TMDL document are reasonable and justified. The TMDL recommendations will be implemented in individual NPDES permits by the DWPC Permit Section.

6. Phased TMDLs

Section 9.0 of the TMDL document addresses implementation of the TMDL in some detail and will not be recounted here. As previously stated, TMDLs in Tennessee are developed and implemented within the context of the Watershed Management Approach. Surface waters will be monitored, reassessed, and the TMDL revised (if necessary) during the watershed cycle.

Recommendations regarding cooperation with the Tennessee Department of Agriculture (TDA) and the Natural Resources Conservation Service (NRCS) for the reduction of agricultural loading are stated and will be accomplished in accordance with the TDEC/TDA Memorandum of Agreement (MOA). Coordination activity between TDEC and TDA has already been initiated.

Recommendations regarding the reduction of urban loading will be implemented with the Phase II storm water program. The regulations for this program specify a deadline of March 10, 2003 for applications from effected entities. Municipal Separate Storm Sewer System (MS4) permits issued under these regulations will be the first permits issued for small municipalities and urban areas.

The recommendations for additional stream monitoring will be implemented during the next watershed cycle. This monitoring will verify the effectiveness of the pollution reduction measures specified in this TMDL and provide data for follow-on analysis, if required. This stream monitoring has already been initiated.